HERB.

BULLETIN No. 10.

Department of Agriculture,

Gold Coast.

FUNGI AFFECTING GRAMINACEOUS PLANTS OF THE GOLD COAST.

BY

R. H. BUNTING, F.L.S.,

Assistant Director of Agriculture for Research and Senior Mycologist.

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FOREWORD.

This *Bulletin* is at once a review of the fungi known up to date to occur on the cultivated and uncultivated grasses of this country and a guide to probably effective methods of controlling the diseases caused by these fungi. It is therefore of unusual value to officers of this and of other Departments of Agriculture and to mycological workers in other countries.

It is probable that certain of the fungi described herein are new to science, while, in other cases, occurrences on certain crops are recorded here for the first time. For these reasons, as well as for the intrinsic merit of the drawings themselves, Mr. Bunting's illustrations are of unusual value.

Two methods of treatment are suggested which should be noted by agricultural officers—namely, the effect of rotation or alternation of crops on the recurrence of certain diseases, and the probable value of seed-sterilization as a means of reducing the incidence of certain diseases. These methods should form the basis of careful field-trials by the Department of Agriculture in order that a definite, numerical statement of their value may be obtained.

G. G. AUCHINLECK,
Acting Director of Agriculture.

ACCRA, *10th May*, 1927.

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PLATE I.

DISEASES OF MAIZE.

A. Leaf-spot (*Ophiobolus heterostrophus* Drechs.)

B. Leaf-blight (*Helminthosporium turcicum* Pass.)

C. Leaf-blotch, cause masked by saprophytic organisms.

D. Mouldy tassel (probably *Ophiobolus heterostrophus*).

E. Black auricle.

F. Ear rot (*Diplodia macrospora* Earle).
Leaf-blotch „ „

FUNGI AFFECTING GRAMINACEOUS PLANTS OF THE GOLD COAST.

A.—INTRODUCTION.

This *Bulletin* is intended to be a preliminary survey of the fungi causing disease to graminaceous crops in the Gold Coast and its Dependencies. It contains in addition notes on the occurrence of certain saprophytic fungi, and of some of the fungi on related hosts.

The desirability of ascertaining something about local cereal diseases seemed to be worth while in view of the economic aspect of supporting the production of food-crops, and may also be defended on the score of the possible occurrence of human and veterinary diseases as resulting from the presence in cereal food-stuff of such parasites as *Ustilago zeæ, Diplodia macrospora, Gibberella moniliforme, Sphacelia,* etc.

In such a survey as has been possible it has been necessary to investigate the subject in a manner too general to permit of conclusive results in many details. As the work progressed many fascinating problems presented themselves for study and had to be abandoned. So that a considerable amount of work remains to be undertaken particularly with regard to the conditions which predispose the host-plant to disease, and to the degree of pathogenicity of some of the organisms under those conditions.

With cultivation of a primitive standard, where many varieties of the same host-plant are grown with apparent indiscrimination, and under varied conditions of soil and moisture, it is apparent that systematic observations over a long period are desirable to permit the collection of reliable etiological data.

The author is, however, of the opinion that, given more enlightened and efficient cultivation, there would be but little permanent danger to fear from fungous diseases attacking the local cereal crops. It appears obvious from field investigations, that the chief factors which assist the maintenance of diseases to such crops as maize and rice are the custom of sowing a second crop on the same land during the second half of the wet season, and the choice—sometimes compulsory—of soil and moisture conditions that are more or less unsuitable for the crop. It is equally apparent that these conditions should be amenable to correction, or amelioration, by more efficient cultural methods than are generally practised.

The impression gained on visiting a diseased maize farm is usually one of general unhealthiness rather than of specific disease, and that feeling is upheld by the number of diverse fungi which can be found on the host. Such farms are not uncommon toward the end of the wet season, and investigation usually shows that a previous crop has been taken from the same land earlier in the year and that no tillage or other method of soil amelioration has been attempted. The result being that any disease, however scanty, which may have occurred during the first crop is on the spot to deal with the weakened resistance of the later one. By contrast, there is probably no healthier crop in the country than maize sown and cultivated under suitable conditions on recently cleared bush land.

The defects of soil, especially those relating to its physical conditions, and the excess or insufficiency of moisture have a direct bearing on the prevalence of certain diseases, and are usually disregarded by the native farmer. One assumes that he has established an economic equilibrium between his needs and his energy, but there remain the facts, that his methods of cultivation could be improved, and that the import of cereal products is maintained from other tropical, as well as from temperate, countries.

Apart from the effect of primitive cultivation on disease, modern progress as demonstrated by transport facilities by rail and road may be held to be largely responsible for the rapid spread of such an epidemic as occurred in 1924-25 by the outbreak of corn-smut. Whilst there is no question but that the epidemic was only made possible by favourable natural conditions it is doubtful if it could have become so quickly and thoroughly widespread in less recent years when travelling was slow and the staple food-crop less liable to transportation.

The author regrets that an anticipated visit to the Northern Territories in connection with this work was not realised. As will be seen from the records of material collected most of the diseases are fairly well distributed over the areas which have been visited in the Colony and Ashanti—a fact which appears to indicate that they have been established for some time.

Their effect on the crops necessarily varies considerably under the varying conditions which obtain locally, but, where so little is known of the results of native cultivation it is almost impossible even to estimate the loss due to fungous diseases for any one year.

In addition to the desirability of affording the crops a suitable cultivation, including an efficient rotation, as a means to improve the host-plants' resistance to the attack of disease, it is thought that the disinfection of seed would considerably assist to diminish the incidence of some diseases in many localities. Trials are being undertaken with the view to ascertain the most practical and efficient method whereby the farmer might be encouraged either to free his seed from potential pathogens or to obtain disease-free seed from official sources.

It is probable that some of the fungi, to which no specific determination has been given in this publication, may be new to science. Where possible, illustrations and a description have been appended in the hope that the organism may be recognised and information received of its proper designation. No apparently new species has been named herein as such because of the desire to avoid a possible multiplicity of synonyms—a not unlikely contingency to be caused by an ardent systematist with the facilities offered by work in such a country as West Africa.

For very valuable assistance in determining the position of the named species, and in clearing up their synonymy, the author is under a real debt of gratitude to Mr. E. W. Mason, of the Imperial Bureau of Mycology, Kew, and to the Cambridge University Press for the excellency of the reproduced, coloured illustration.

B.—DISEASES OF MAIZE.
(Zea Mays L.)

CORN SMUT.
(Ustilago Zeæ (Beck.) Ung.)

The history of this disease in the Gold Coast Colony and Ashanti is not known with any degree of accuracy. It is said to have occurred in the Central Province some years ago, and to have been found on the road from Sekondi to Impohor in 1917, but unfortunately these statements cannot be authenticated.

In any case such attacks cannot have been severe, since the occurrence of so obvious a disease on the staple food of the country, it at all common, could not have been overlooked, nor is it likely that a severe attack would have been forgotten by cultivators who have recently been questioned as to their knowledge of the disease and who have been unanimous in declaring it to be previously unknown.

Enquiries of neighbouring countries have elicited the information that, with the exception of a district in Senegal, corn-smut is not known to exist within a very large radius of the Gold Coast.

In July 1924 an outbreak of the disease was reported from the Central Province, and a rapid survey of the corn-areas was made during the main crop of that year, which showed a distribution strongly suggesting that the railway and two well used roads had carried smut from one of the chief ports of entry. During the second crop of that year many new localities were recorded as infected, and the main crop of 1925 showed an extension eastward into British Togoland.

An attempt to estimate the comparative incidence of disease per acre during the second crop of 1924 was rendered almost impossible by the irregular manner of sowing, and by the fact that all the culms arising from the number of seeds planted in one hole are allowed to develop by native cultivators. In one of the worst cases seen by the writer it was estimated that at least 25% of the culms were infected and that 66% of the stands contained infected culms.

Whether or not corn-smut be endemic, the rapid dissemination of the disease which assumed epidemic proportions in 1924-5, and subsequently diminished, indicates that favourable conditions for the development of the parasite then obtained. An attempt to correlate available meteorological records with the outbreak has,

PLATE II.

DISEASES OF MAIZE.

A C

B

H.A.D. *photo*

Corn Smut (*Ustilago Zeae* (Beck) Ung.)

A and B. On ears.
C. On tassels, showing production of female organs (corns) in the male inflorescence.

however, afforded no light on that point. The rapidity with which the disease spread over a wide area may be regarded as being assisted by the modern facilities for quick transit which are provided by railway and motor roads, as well as by the cultural conditions under which maize is normally grown in this country.

Symptoms.

The well-known hypertrophic symtoms, shown in Plate II., differ in no way from those familiar in nearly all other maize countries. The majority of cases consist of infection in the axils of the leaves, or of female flowers, resulting in the transformation of potential grain into soft tumours of varying size which are glistening white until they rupture and disclose black powdery masses of spores and distorted fibres.

Similar tumours arise on the culms or leaves, and frequently the staminate inflorescence of a smutted plant produces female organs which give rise to more or less normal grains or tumours. The effect on the host-plant therefore consists of a considerable diminution of grain that can be utilised either as food or seed. Weatherwax [25 :p.79]* states regarding corn-smut that " this fungus destroys the ear in many instances, and is very objectionable when introduced into foods made from the plant for man or for live stock. In silage its effects are obvious. Cattle that have eaten large quantities of ears partly destroyed by smut sometimes suffer from poisoning similar to that due to the ergot of rye ".

Infection.

The chlamydospores released from a mature tumour are capable of resting for a considerable period before germinating in moisture, but, given a suitable medium, they may germinate at once. From the promycelium so developed arise small sporidia which by budding increase their number, more or less indefinitely, dependent upon the nutritive value of the medium in which they arise. Infection takes place by the germination of a sporidium in contact with any part of a maize plant which is actively growing, the older parts of the host-plant being resistant to attack. Infection is practically always localised, and results in the formation of a tumour within about three weeks.

Predisposing Conditions.

In other countries it has been found that infection is favoured by the tender development of the host-plant caused by forcing conditions which accelerate its growth and afford a surplus store of food, and by a moist atmosphere. In this country where the native farmer usually sows two successive crops on the same land, the parasite has an obvious opportunity to increase its incidence of attack.

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*Throughout this Bulletin numbers in square brackets refer to the Literature cited in the List on page 50.

Close planting of corn may also be considered as of assistance to the disease since suitable moisture conditions are thereby assured.

Control.

The points to be remembered in attempting to combat corn-smut are :—

(1) the potentiality of chlamydospores to germinate after a period unfavourable to germination, which period may amount to some years ;
(2) the ability of chlamydospores to retain viability after passing through the alimentary canal of animals ;
(3) the necessity of moisture and a nutrient medium, *e.g.*, manure, rich soil, for the germination of chlamydospores ;
(4) the saprophytic ability of the fungus to remain viable in its sporidial stage given a suitable medium ;
(5) infection by sporidia ;
(6) infection restricted to the actively growing parts of the host ; and
(7) distribution of both kinds of spores by wind, insects and other animals.

Experiments to prevent the development of corn-smut are said to have been started in 1760, and are now being directed to the breeding of resistant strains of maize.

Methods of cultivation *e.g.*, selection of seed from non-infected sources, satisfactory rotation and spacing, are usually all that is required in other countries to reduce the disease to such a percentage of infection that it would be uneconomical to apply special methods of control such as spraying.

In this country, the habit of sowing a second crop on infected land should be discontinued ; the use of grain obtained from an infected crop should be avoided for seed purposes ; a rotation which prevents maize from being sown within three years on the same land should be adopted ; all infected material should be burnt before its tumours are fully developed ; all maize trash on an infected farm should be burnt, and no domestic animals permitted to eat uncooked smutted corn.

Causative Fungus—*Ustilago zeæ* (*Beck.*) *Ung.*

SORI, produced within the hypertrophied epidermis of the host, forming swellings up to 60 microns long and 25 microns wide.
SPORES, globose or shortly elliptical, light brown, finely spinulose; 8 to 11 microns ;
PROMYCELIUM, cylindrical, 3 to 4 times septate, bearing numerous spindle-shaped sporidia.
ON all parts of Zea Mays L., generally distributed throughout the maize producing area. 1924 and 1925.

BLACK BUNDLE DISEASE OF MAIZE.
(Cephalosporium acremonium Corda.)

This disease, which was described in 1924 by Reddy and Holbert [15] for America, appears to occur in various parts of the maize producing districts of this Colony, an authentic case having been collected at Asuansi in June 1926, and many undetermined cases seen elsewhere which, in the light of more recent knowledge, would no doubt be correctly diagnosed under this head.

In very many farms there may be found plants bearing one or more of the group of symptoms associated by the above workers with the black-bundle disease, and the desirability of further work on such local manifestations seems obvious.

Symptoms.

Reddy and Holbert give as the most distinguishing symptom the presence of blackened vascular bundles in the stalks and sometimes in the leaves. This symptom occurs fairly frequently in some districts here, as do the following associated symptoms which are frequently additional demonstrations of the disease—a red or purple discolouration of the leaves or stalk extending downwards from the apex of the plant, the formation of imperfectly developed ears, barren stalks, or stalks bearing a number of ears at one node, and excessive suckering.

The above-mentioned workers consider that whilst some of the above symptoms may be caused by other agents, the presence in the host-plant of *Cephalosporium acremonium* Corda, is one of the most important causes in producing the group of symptoms associated with black-bundle disease of maize, and state that " The group of symptoms under discussion may occur to some extent without the presence of *C.acremonium*. Only careful examinations and analyses can determine when this organism is responsible for these symptoms. It is also true that infections may be quite general in corn without the presence of any of these symptoms to a marked extent, except the blackened fibro-vascular bundles " [15 : p. 189].

Cephalosporium acremonium has frequently been found in this country associated with diseased maize material and other plants, and it was undoubtedly present in the blackened bundles of a culm collected at Asuansi.

Control.

Reddy and Holbert advise the avoidance of grain from plants showing any of the group of symptoms of the black bundle disease for use as seed. They consider the best method of control will come with the development of resistant strains of maize, and state that preliminary seed treatment experiments offer promise of control of this disease.

Causative Fungus—*Cephalosporium acremonium* **Corda.**

The fungus is characterised by its spherical, mucilaginous heads of nonseptate spores borne on simple conidiophores on a hyaline, infrequently septate, mycelium.

In America the organism is said to enter the seed through the vascular system, thus permitting the disease to be seed-borne. Its presence does not generally affect the early vigour of the resulting plants, so that tests of germination do not indicate infection, and the symptoms of disease are not usually evident until the host-plant is well established.

MYCELIUM, creeping, hyaline, infrequently septate, bearing short, awl-shaped, usually non-septate conidiophores, up to 20 microns in length;
SPORES, cylindrical, hyaline, 4 to 6 by 1.5 microns, collected in spherical heads at apex of conidiophores by mucilage.
FROM discoloured vascular bundles of Zea Mays L, Asuansi.

BROWN SPOT OF MAIZE.
(Physoderma Zeæ-maydis Shaw.)

This disease of maize has been collected in Ashanti and in the Eastern Province of the Colony, and has been found of such prevalence as to affect up to 46% of the plants, and 54% of the stands in a field of young corn.

It was first recorded in India, later in the United States of America. A similar, and probably identical, disease was previuosly described in Japan, but the causative organisms of the two diseases have not been compared.

Symptoms.

The presence of the fungus which causes "brown-spot" is readily discernible on an infected plant by the dark, purplish-brown spots which may occur on the blade or sheath of the leaf (Plate III., figs. C, B, D), or on the culm (fig. D), rarely on the husks of the ear.

The spots occur in irregular masses, or distinct from one another and from the normal green colouration for the healthy tissue as is shown in figure C. They measure at first not more than one millimetre in diameter, but frequently develop in size up to five millimetres. These usually orbicular, discoloured areas may remain distinct, or, by their confluence and by the necrosis of intermediate tissue, give the appearance of a more or less solid, purple-brown discolouration to a large area of the host similar to the effect produced on the leaf-sheaths of figure A.

Frequently the appearance of the spots is heralded by a yellowish change in colouration of the area affected. The ultimate result produced by the fungus is the desiccation and rupture of the epidermis and the production of dusty masses of brown sorangia.

PLATE III.

DISEASES OF MAIZE.

Figs. A to D.—Brown Spot (*Physoderma zeae-maydis* Shaw). Fig. A.—Severe infection of leaf-sheaths of young plant. B.—Periodic infection caused by moisture lodging at different levels as leaf-sheath and culm developed. C.—Infection of lamina and auricle. D.—Old infection about to liberate sporangia.

Fig. E.—Leaf-spot II (*Acrothecium lunatum*, see p. 16).

Fig. F.—*Marasmius* leaf-blotch.

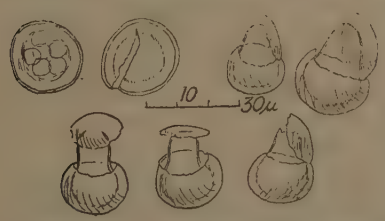
Effect.

The actual damage caused to a maize plant by the parasite may be almost negligible if infection does not take place until the grain is set and ripening, but when a heavy infection occurs at an early stage of the host's development—as is shown in fig. A Plate III—the production of grain suffers by restriction, either partial or complete, of the normal function of the leaves, and the whole plant may be destroyed by an attack on the nodes ultimately causing the culm to break.

The fungus is considered as responsible for one of the worst diseases of maize in the United States of America, where plant quarantine measures against it were established in 1916. Very serious damage to the crop is said to be caused by it in those States which have a considerable amount of moisture and a continuous high temperature during the early part of the corn-season. Observations of the disease in this country also indicate similar predisposing conditions.

Infection.

Physoderma Zeæ-maydis belongs to a primitive group of fungi which inhabit the cells of their host-plants. The brown-spot disease of maize is reproduced by the development of numerous sporangia within the cells of the host tissue. Upon the disintegration of the latter the sporangia escape, and are distributed by various agents. They are sufficiently thick-walled to be resistant to many months of drought, but in contact with water germination is rapidly effected in the manner shown in the accompanying figure. After segmentation of the contents of a mature sporangium, a fissure appears in the outer wall and the resulting segment is either completely detached or is pushed aside by the swelling endosporangium which is protruded to form an inverted funnel-shaped vesicle, from the apex of which a number of uniciliate zoöspores are released. The zoöspores after swimming about for some time settle down and produce a fine hypha by means of which the epidermis of the host-plant is penetrated and its cells permeated; sporangia are developed within the cells, and the life cycle begins again.



The necessity of free moisture for the act of infection is obvious, and is demonstrated by the localised occurrence of the fungus on an infected plant. Wherever water is retained by parts of the plant, *e.g.*, leaf-sheath, base of lamina, auricles, there infection is most frequent. By the development in length of the internodes and the growth of the leaves new areas are continually

being exposed to favourable conditions for infection. An illustration of the periodicity of the infection of a leaf-sheath is shown in figure D, Plate III where successive infections have occurred as moisture accumulated every night between the auricles of the lower leaf and the leaf sheath they clasped.

It has been found in America that the resting sporangia " live over winter on the diseased plants and in the soil and are carried in spring and summer by wind and other agencies to the young corn plants " [24].

The incidence of attack is, as might be expected, markedly influenced by the period of time which is allowed to elapse between successive crops of maize. The author is indebted to Mr. T. Hunter of Kumasi for data of the 1926 maize crop which show that, on land continuously under maize since 1923, 60.2% of the culms were affected, and 12.7% destroyed, by the disease, and 55.9% were affected and 29.8% destroyed on a plot which bore maize the previous year, whereas on virgin soil only 2.1% were affected and 0.75% destroyed, and on plots not under maize for the previous two or three years there were rather more than 15% of the culms affected and from 2 to 5.8% destroyed.

Control.

From a consideration of the life-history of the parasite it is apparent that an attempt to control the brown-spot disease of maize should include the destruction of diseased material before the sporangia have been liberated; the institution of a satisfactory rotation of crop, and of necessity the reduction of excessive moisture conditions.

The treatment, with alcohol and subsequently with sulphuric acid, of grain used as seed has been proved to be effective against *Physoderma* [26], and other methods of seed disinfection should be equally successful.

Causative fungus.

Physoderma Zeæ-maydis Shaw.

SPORANGIA ZOOSPORES	ellipsoid ovate to globose, 20 to 25 by 14 to 25 microns, light-brown uniciliate.
ON	culms and foliage of *Zea mays* L., Juaso, Kumasi, Ejura, Mampong Ashanti, Odumase, Axim and elsewhere.

LEAF BLIGHT OF MAIZE.
(Helminthosporium turcicum Pass.)

Various popular names are given to this disease in other maize producing parts of the world, *e.g.*, leaf-spot, leaf-scorch, white blast, yellow-leaf, helminthosporiose. It occurs in many parts of the Colony and Ashanti, and will no doubt be found in all the corn areas of the forest belt. The list of countries from which leaf-blight of maize has been reported is a long one; Butler [2 : p. 201] gives

beside India, Italy, the United States of America, South Africa, Japan and the Philippines, Drechsler [4 : pp. 712-3] adds France, New South Wales and possibly Russia, and Small [19 : p. 11] records its occurrence in Uganda.

Symptoms.

Affected portions of the leaf are at first small and chlorotic, increasing in area into longitudinal blotches of a straw to grey-brown colour, and usually become demarcated by a narrow band of a slightly deeper tone (Plate I., fig. B). These lesions which consist of the desiccated tissue of the host may occupy a considerable area, and are practically always of greater length than breadth. Under moist conditions their surface becomes covered with olive-green, velvety masses of conidiophores, and the whole leaf eventually withers in a manner suggestive of the effect of fire or frost.

Effect.

The amount of damage done to the host appears to depend upon the value of the affected leaves to the plant. Thus the destruction of old leaves which may already be more or less moribund at the time of attack has little effect upon the plant's development. But when external conditions favour an attack upon young foliage considerable damage may be caused by retarding development, and according to some observers to such an extent that the host is killed. Reinking [16 : p. 140] reports on the destructiveness of this disease in the Philippines as having destroyed fields of corn, it being " especially severe on newly introduced corn which is not acclimated, and is in a weakened condition ".

Control.

The means by which the parasite retains its vitality during the period when no economic host crop is available is not known ; it is said to occur on sorghum in America [22] and in India [11] [18], and in the latter country its development has been induced on wheat, barley, oats, sugar-cane and rice [18]. In this country it has so far only been found on maize and *Andropogon halepense*. So that it is possible that it persists by utilising other hosts than maize.

In this connection it should be remembered that both Shaw [18] and Mitra [11] have stated that the parasite, whilst morphologically similar on maize and sorghum in India, appears to be divided into biological strains, each of which can infect the host-plants mentioned above.

In the absence of further knowledge regarding the life-history of the fungus, preventive measures against its occurrence can only consist of rotation of crops and destruction of infective material.

Infection.

According to Mitra [11] infections take place either directly through the epidermis of a maize leaf or through stomata. The conidia of the fungus in this country germinate readily in water at both poles, it has never been observed to take place from intermediate cells, but occasionally two germ tubes have been produced from one of the polar cells. The spores of *H. turcicum* are said to retain their vitality for a period of three months in the Philippines, and Marquez [8] reports positive results from the infection, with pure cultures of the fungus, of soil in which maize seed was germinated.

Causative fungus.

Helminthosporium turcicum Pass. (syn. *H. inconspicuum* C. & E.) Plate IV, figs. A—D.

Only the conidial stage of the parasite is known. It differs from other species of the same genus found on graminaceous hosts here, by its stouter, nearly straight sporophores, and by the protruded, narrow hilum and decidedly tapering outlines of its usually straight spores. Of the figures shown on Plate IV, the spores cultivated on tap water agar, denoted by B, may be taken as typical; that marked C shows somewhat exceptional breadth, whilst the sporophore of figure D from the leaf of *Andropogon halepense* is rather longer than usual.

SPOROPHORES, brown, almost straight, 100 to 380 by 7 to 10 microns with 3 to 8 septa, arising in groups of 1 to 3 from stomata.

SPORES, fuliginous; straight or very slightly curved, tapering to both ends, widest usually below the middle, 3 to 7 times septate, with a narrow, pronouncedly protruding hilum, 45 to 128 by 15 to 28 microns.

ON leaves of *Zea mays* L. at Aburi, Krobo, Ejura, Juaso and Kumasi, and onl eaves of *Andropogon halepense* in the Krobo country.

LEAF-SPOT OF MAIZE—I.

(Ophiobolus heterostrophus Drechsler; conidial stage.)

Considerable confusion has arisen from local collections of diseased maize foliage bearing species of *Helminthosporium*. A collection made at Aburi agreed in symptoms, and in the conidial stages of the causal organism, with those described by Drechsler's paper on " Leaf-Spot of Maize caused by *Ophiobolus heterostrophus*, n.sp., the ascigerous stage of a *Helminthosporium* exhibiting bipolar germination " [5]. Later a similar conidial form was found to produce the same symptoms on maize grown at other localities.

Distribution.

Drechsler—whose paper has disentangled the muddle which had confused the causal organisms of leaf-blight and leaf-spot—states therein that his leaf-spot occurs on maize and teosinte (*Euchlæna mexicana* Schrad.) in the Philippines, and on maize in Florida, and that it "is probably widely distributed in tropical and sub-tropical maize-growing regions, having evidently been confused with leaf-blight which occurs in the same territory".

Symptoms.

The lesions are buff in colour, bordered by a brown margin, irregularly elongated up to 3 mm. in length, and rarely exceed in width the space between two adjacent veins. Figure A of Plate I is characteristic of their appearance. Large numbers of spots occur and apparently cause considerable damage to the leaf.

Causative fungus.

The ascigerous stage of *Ophiobolus heterostrophus* has not yet been observed in this country, although small, stromatic-like bodies have been found in the mycelium of dried-up cultures which suggested incipient perithecia.

Plate V shows the difference of the sporophores and spores as compared with those of *Helminthosporium turcicum;* the former being narrower, whilst the conidia are more curved, less wide in proportion to their length, contain more septa, and do not show the protruded hilum characteristic of the latter species.

The determination of the local fungus has been based on a comparison of the long-spored species of *Helminthosporium* found in Baker's Fungi Malayana, No. 239 in Herb. Kew, Dr. Drechsler having stated (in lit.) that the long-spored form often present in this exsiccatum is his species.

SPOROPHORES,	140 to 255 by 8 to 10 microns, brown, 3 to 5 times septate arising in groups of 1 to 3 from stomata;
CONIDIA,	60 to 125 by 12 to 17 microns, curved, tapering to both ends, 5 to 11 times septate, with an inconspicuous hilum.
ON	foliage of *Zea mays* L. at Aburi and Satatsu, Ashanti; probably on male inflorescences of *Zea mays*, Aburi and elsewhere.

Dreschsler's diagnosis of the ascigerous stage [5 : p. 724] may be summarised as follows :—

PERITHECIA,	erumpent, black, somewhat ellipsoidal or sub-globose, 0.4 to 0.6 mm. in diam., 0.4 mm. high, with ostiolate beak;
ASCI,	numerous, short stipitate, subcylindrical, 160 to 180 by 24 to 28 microns, containing four spores arranged in a multiple, heterostrophic, helicoid manner;
ASCOSPORES,	filamentous, fuliginous, five to nine times septate, constricted at septa, 130 to 340 by 6 to 9 microns.

LEAF-SPOT OF MAIZE.—II.

Another leaf-spot of maize with symptoms which appear to be distinct from those of the previously mentioned disease has been collected on separate occasions at Juaso in Ashanti and from other localities. In the first collection made at Juaso there were present on the lesions two species of Dematiaceous fungi the more evident of which is discussed here under the name *Acrothecium lunatum*, whilst its companion appears closely to approach *Helminthosporium sativum* (pl. IV, fig. J.) The disease was common on a field of maize which had to be condemned on account of the number and prevalence of the diseases present.

More recently there have been found in the same district mature maize plants the foliage of which was abundantly affected by spots from which nothing but *Acrothecium* could be obtained. Still later a *Fusarium* occurred with *Acrothecium* in cultures inoculated direct from a spot. So that, whilst the constant association of *Acrothecium lunatum* with these spots and the taxonomic interest of the fungus appeared to justify its inclusion here, it is not to be assumed that this species is necessarily the causative organism.

Symptoms.

The spots (see Plate III, figure E), measuring from 0.5 to 7.0 mm. are occasionally in contact with one another but appear not to coalesce, in colour they are greyish buff, tending to zonate around a small, white, translucent spot, and bordered by a dark purplish-brown margin which is again surrounded by an irregular areola of chrome yellow. The fructifications of the associated fungus occur in large numbers on both surfaces of the leaf.

Associated Fungus.

Acrothecium lunatum Wakker sec. Mitra.

In 1916 Saccardo [17] published a new species of *Helminthosporium* on maize under the name of *H.curvulum*, which he later recorded as occurring on the leaves of *Bambusa blumeana*, and in 1919 authentic material of the fungus on the male inflorescences of maize (Baker's Fungi Malayana, No. 239) was published. In this exisccatum there are two distinct species both with curved spores, those of the one species being much shorter and with constantly less septa than the other. As Drechsler [5] points out, Saccardo's name *H. curvulum* refers to the smaller spored of the two species. The Gold Coast material has been compared with Baker's numbers 217 and 239, both of which are labelled *Helminthosporium curvulum* Sacc. in *Herb. Kew*, and may be regarded as authentic material since Saccardo determined the exsiccata published by Baker.

Spores and sporophores of Baker's No. 217 are shown as figure H on Plate VI, those of Baker's No. 239 are figured on p. 710 of Drechsler's paper on *Ophiobolus heterostrophus* [5].

A comparison of these figures with those of the Gold Coast material (Plate VI, fig. A-G) confirms the identity of the latter with Saccardo's *Helminthosporium curvulum*.

A culture of the local fungus from maize has been kindly determined by Mr. Mitra as *Acrothecium lunatum* Wakker as known to him in India where it is a saprophyte or weak parasite on many grasses. Mitra [10] also records the species as occurring on maize tassels, so that, *Acrothecium lunatum* Wakker and *Helminthosporium curvulum* Sacc. may be considered to be synonymous. To what genus the fungus should ultimately be referred would appear to depend upon further observations. The development of the conidial cells offers differences from that of the cells of *Helminthosporium;* in culture the number of spores borne pleurogenously would seem to indicate a closer affinity to *Spondylocladium* than to *Acrothecium;* whilst Maublanc and Delacroix [3 : Pl. XVIII, fig. 7] illustrate similar conidia as preceding the appearance of the perithecia of *Leptosphæria sacchari* van Breda de Haan on sugar-cane. The fungus is here recorded under Wakker's name as being the older designation, and until the matter has been more fully investigated.

Occurrence.

In addition to its presence on leaf-spot of maize (Pl. III, fig. E, and Pl. VI, figs A,D,E), strains morphologically similar to *Acrothecium lunatum* have been collected in this country,

(*a*) from leaf-spots attributed to the conidial stage of *Ophiobolus heterostrophus*,
(*b*) in association with a species of *Helminthosporium* on necrotic maize auricles (Pl. I, fig. E),
(*c*) as a mildew associated with the same species of *Helminthosporium* on maize leaf-sheaths (Pl. VI, fig. G),
(*d*) in association with *Helminthosporium oryzæ* on the glumes of rice (Plate VI, fig. F),
(*e*) on the foliage of sugar-cane, and
(*f*) on the foliage and glumes of Guinea-corn.

Shaw [18] records it on *Setaria italica*, *Panicum frumentaceum*, *Eleusine coracana*, and many other plants in India, and as already stated the same fungus has been described on *Bambusa blumeana*, and on sugar-cane elsewhere.

Pathogenicity.

The degree of pathogenicity of the Gold Coast fungus has yet to be determined by experimental work. Such inoculations of young maize leaves as have been made have given inconclusive results. It is usually found in association with other fungi, some of which are not definitely known to be parasitic. Shaw [18] considers it to be a weak parasite producing small spots in India, and that is possibly its habit here.

There is, however, always the possibility that the *Helminthosporium*, with which it is so frequently associated on the leaf-spot mentioned above, may prove to be the conidial stage of *Ophiobolus heterostrophus* in which case it might be fair to assume that the apparent difference between that leaf-spot and the one described by Drechsler is a modification of the latter caused by the presence of *Acrothecium lunatum*.

The fungus grows readily on artificial media. On cassava mush agar the mycelial hyphæ tend to form strands before producing somewhat elongated sporophores, and in old cultures, to produce submerged subicula of darker, thick walled, frequently septate and swollen hyphæ that suggest catenulate chlamydospores. Conidia developed in either cassava mush agar or tap water agar are at first almost spherical, after division in a horizontal plane the apical cell becomes larger and both cells again divide horizontally, so that the mature spores in these media are more generally developed in a straight line, as is shown in figures B and C of Plate VI, than in a bent or curved manner. The spores are borne acrogenously but by development of the apex of the conidiophores large numbers of apparently pleurogenous spores occur in luxuriant growth.

SPOROPHORES, brown, straight, slightly geniculated toward the apex, 4 to times septate, 65 to 250 by 5 to 7 microns, up to 340 microns in length on rice glumes, arising in groups of 2 to 5 from stomata.

SPORES, light brown, sometimes almost hyaline with darker central cells 3 to 4 times septate, third cell from base always the largest, apical cell rounded and frequently borne in a contorted manner to produce a curved or rectangular axis, basal cell narrowed to a conspicuous hilum, 20 to 32 by 9 to 12 microns;

ON foliage of *Zea mays* L., Juaso, Aburi, Bunso, Odumase, Asuansi; on glumes of *Oryza sativa* L., Adebrem; on foliage of *Saccharum officinale* L., Asuansi; on glumes of *Andropogon sorghum* L., Asuansi.

MAIZE RUST.

(Puccinia maydis Bereng.)

Maize rust is fairly commonly distributed in this country, and occurs in many other of the warmer parts of the world including Southern Europe, India, Australia and the United States of America.

The disease is rarely of considerable economic importance, but occasionally, during periods of excessive humidity, it may develop sufficiently early, and to such an extent, as to cause the affected foliage to wilt and dry up with consequent loss of crop.

Symptoms.

Small yellow spots occur on both sides of the leaf, become reddish-brown and elongated, and rupture, disclosing, between the longitudinal lips of the burst epidermis, pustules of light brown uredospores. Later the spots become larger and black, and reveal similar pustules of dark teleutospores.

Control.

Operations for the control of maize rust are usually not considered as an economic proposition; the most practicable method in this country would be to remove rusted leaves or, in the case of bad infection, the whole plant, and destroy them by fire.

Causative Fungus.

Puccinia maydis Béreng. (Plate IX, fig. D).

The fungus is said to be heterœcious, the aecidial stage having been demonstrated elsewhere to occur on species of *Oxalis*, and to have been known previously under the name of *Aecidium oxalis* Thuem. The aecidial stage is not yet known to occur in this country.

It is also recorded on *Euchlæna mexicana*—a near relative of *Zea mays*—for America, but does not occur on *Sorghum* in spite of its synonymous binomial *P.sorghi* Schw. (non Fckl.)

AECIDIAL STAGE	not known locally.
UREDINIAL STAGE,	sori amphigenous, numerous, sometimes confluent pustular; spores usually globose, sometimes ovoid, light yellowish brown, finely spinulose, 25 to 30 by 23 to 28 microns;
TELEUTOSPORES,	arising from periphery of uredo sori, chestnut brown, smooth, ovate or oblong, constricted at septum, bluntly pointed at apex, epispore thick especially at apex, 33 to 45 by 18 to 20 microns; pedicel, persistent, light brown, long, 4 microns in width increasing to 5 at the top;
ON	the foliage of *Zea mays* L., Bisa, Kibi, Bekwai, Kumasi, Ejura, Aburi.

BLACK-AURICLE DISEASE OF MAIZE.

The condition depicted by figure E of Plate I has been found to be frequent in many farms. No detailed observations of it have been made as it is not considered to be of sufficient economic importance, although it may indicate a general unhealthy condition of the host-plant especially when it occurs on the younger leaves.

Symptoms.

The symptoms are obvious; the almost colourless wedge-shaped areas, situated between the blade and sheath of a leaf and expanded to form auricles, become brown at the edge, the discoloration extending inwards to the mid-rib, darkening to black, and usually sharply demarcating that area from the normal coloration of blade and sheath.

The most commonly found fungi on dead or moribund auricles are *Acrothecium lunatum* Wakker (for a description of which see p. 16), and a species of *Helminthosporium* closely allied to if not identical with, *H.sativum* Pammel, King and Bakke.

Associated Fungi.

The latter fungus closely resembles that described on p. 16 as probably the conidial stage of *Ophiobolus heterostrophus* Drechsler, except that on artificial media the sporophores are more contorted by more frequent and pronounced geniculations at the distal end, and that the spores are usually darker in colour.

The spores of this fungus, figured under G of Plate IV, were obtained from a black auricle, and those marked H were developed on tap-water agar from the same source.

The same species frequently causes black, mouldy patches on the leaf-sheaths and husks of old maize plants, on which more or less moribund media it cannot be regarded as more than weakly parasitic. Figure E of the same plate shows spores and sporophores taken from such a situation, and figure F. a tap water derivative of the same.

As has been mentioned (p. 16) a *Helminthosporium* species, considered to be identical with this fungus, occurs in association with *Acrothecium lunatum* on certain leaf spots of maize.

Whether the fungus is distinct from the conidial stage of *Ophiobolus heterostrophus*, or is to be regarded as *Helminthosporium sativum*, requires investigation based on further cultural trials. It may be described as follows :

SPOROPHORES, 100 to 330 by 8 to 9 microns, brown, 6 to 9 times septate, more or less geniculated at distal end ; in artificial media, up to 500 microns in length, up to 30 times septate, contorted by frequent geniculations at distal end, sometimes branched with a straight and slender basal portion, arising from torulose mycelium ;

SPORES, 30 to 130 by 10 to 17 microns, olivaceous, 4 to 13 times septate, straight or slightly curved, usually tapering to distal end, with enclosed and conspicuous hilum, in artificial media they are usually shorter and more ellipsoidal, 4 to 9 times septate, darker in colour with the basal and apical end sometimes conspicuously lighter. Germination is bipolar.

There has also been found occasionally on black auricles a second species of *Helminthosporium* with dark brown, straight, 7 to 15 times septate, conidiophores, which measure up to 470 microns in length, and bear a few, fuliginous, usually rostrate, 8 to 17 times septate, spores, with a protruded hilum, and a measurement of 80 to 260 by 14 to 22 microns.

LEAF BLOTCHES OF MAIZE.

Considerable difficulty has been experienced in an attempt to ascertain the causes— and to differentiate their effects—of the numerous elongated areas of dead tissue which occur on mature maize leaves locally, and which may conveniently be termed leaf-

blotches. Of these, some appear to be caused by sun-scald and become the medium on which numerous saprophytes develop, whilst other causes no doubt occur. Figure C of Plate I. illustrates a case in which the cause of disease has been concealed by the numerous fungi which have invaded the affected area—ten distinct organisms having been found thereon.

There are, however, three leaf-blotches of maize which appear to be fairly distinct—that figured B on the same plate has been described as leaf-blight caused by *Helminthosporium turcicum* (p.12), and is differentiated by its grey, velvety covering of conidiophores; the one, now to be described, with which *Diplodia macrospora* Earle is associated, (illustrated by figure F of Plate I) may be recognised by the presence of easily discernible, black pycnidia, and that which follows (p. 22), caused by a species of *Marasmius* and figured F on Plate III, is much lighter in colour, with a more translucent substratum and bears typical, though small, sporophores.

DIPLODIA MACROSPORA EARLE ON MAIZE FOLIAGE.

Symptoms.

The lesions, which may not be more than ten millimetres in width, extend in a direction parallel to the axis of the leaf blade for a distance of as much as thirty centimetres, and in severe cases occur in numbers on any one leaf. In slight affections the lesions may be much smaller. They are usually of a clear, straw to light cinnamon-brown, colour with a somewhat darker border which tends at the extremities of the affected area still further to increase its length by acute prolongations into the normally coloured tissue.

The black pycnidia appear as small dots scattered in lines on both surfaces, but principally on the under side, of the leaf. On the leaf-sheath the effect of the fungus is less noticeable, but its presence is clearly demonstrated by the occurrence of the distinct black dots that denote pycnidia.

The disease may or may not be serious according to the incidence of attack which appears, by observation only, to depend rather on the general condition of the host-plant than on the positive pathogenicity of the organism.

Associated Fungus.

Diplodia macrospora Earle (Plate VIII, fig. A).

Rather large, black pycnidia develop below the epidermis of the host and at maturity produce an erumpent ostiole; they are usually more or less oval on a horizontal plane, measuring up to 550 microns in their longer diameter. The spores are olivaceous-brown, with somewhat thick walls, usually once septate, though three celled

spores have been found in nearly all pycnidia examined, they are more or less cylindrical in shape, many of them being irregularly clavate, and measure up to 90 microns in length by 10 microns in width.

The taxonomy of the fungus is open to discussion. It is recorded here as *Diplodia macrospora* Earle, because that is the binomial by which it is known in the United States of America. It is, however, considered by some systematists as being a form of *Diplodia zeæ* (Schw.) Lev., a species that is responsible for a great deal of damage to maize in America, and one which has not yet been found in this country. *D. zeæ* has been referred to *Macrodiplodia* by Petrak (Ann. Mycol., XXI, p. 189, 1923), and to a new genus *Phæostagonosporopsis* by Woronichin (La Défense des Plantes, Leningrad, II, pp. 331-4, 1925), whilst *D. macrospora* Earle is considered by von Höhnel (Hedwigia, LX, pp. 147-8, 1918) to be the same fungus as was described by Sydow (Ann. Mycol., XV, p. 258, 1917) as *Stenocarpella zeæ nov. gen. nov. spec.*

The synonymy is considered to be :—

Stenocarpella zeæ Sydow, 1917.
Macrodiplodia macrospora von Höhnel 1918.
Diplodia zeæ (Schw.) Lev. var. *macrospora* (Earle) von Höhnel 1918.
Macrodiplodia zeæ (Schw.) Petrak & Syd. var. *macrospora* (Earle) Petrak & Syd. 1923.

Diplodia macrospora also occurs on the cobs of maize, and is further discussed under ear-rots on p. 26.

SPOROPHORES, scattered, black, large, more or less oval in horizontal plane, subepidermal, erumpent by ostiole, 300 to 550 by 280 to 460 microns horizontally ;

SPORES, olivaceous-brown, thick walled, straight or slightly curved, cylindrical or irregularly clavate, once or twice septate usually constricted at septum, rounded at apex, more or less elliptic at base. 45 to 86 by 6 to 9 microns ;
on foliage of *Zea mays* L. Juaso, Ejura, Essiama.

MARASMIUS SP. ON MAIZE FOLIAGE.

An uncommon affection of maize foliage is figured on Plate III, figure F. The disease has only been recorded on three occasions in this country and has not apparently been found elsewhere.

Symptoms.

Large areas of the leaf are affected and are bounded by the edge of the lamina ; they extend to a length of 20 cm. and to a width from 1.8 to 3.0 cm., the outer portion—presumably the seat of infection—is translucent and may be lightly tinted a cream colour ; irregular, more or less concentric, zones of a darker buff colour occur around the translucent area, and each zone is more or less distinctly demarcated by irregular borders of a buff to dull brown colour.

Associated Fungus.

Sporophores of a species of *Marasmius* are borne on the under surface of the older portions of the affected area, and on that account have their stipes usually strongly recurved. They arise from a mass of mycelium formed beneath the epidermis adjacent to a vein. Hyphæ of the fungus occur within the xylem vessels. No mycelial thread has been found, but there is a strong resemblance between the sporophores of this fungus and those described by Petch [14 : p. 25] for *Marasmius scandens*, the cause of the local White Thread disease of Cacao.

There appears to be no doubt as to the pathogenicity of the fungus. No other organism of pathogenic importance was found on the areas effected, and indication of the Marasmius being causal seemed to the author to be sufficient.

The fungus is believed not to have been described hitherto; the following description is compiled from the scanty material available,—

PILEUS, pale cream, floccose, up to 2 mm. in diameter, thin, in section consisting of a somewhat loose reticulum of thin walled cells overlying the trama, conchiform, somewhat orbicular in young specimens, strongly convex, usually sulcate over the gills which may be absent or up to 5 in number white, sometimes forked, ventricose and adnate : no cystidia were found ;

STIPE, dark brown tending to become lighter at apex, flecked with white flocci, usually bulbous at base, more or less hollow at maturity, usually strongly recurved, 1.0 to 1.25 by 0.12 mm ;

SPORES, hyaline, smooth, ovate, apiculate, 6 to 8 by 5 microns ;

ON foliage of *Zea mays* L., Bunso and Asuansi.

OTHER FUNGI ON MAIZE FOLIAGE.

A large number of fungi usually occur on the diseased, or dead, areas of maize leaves, the original cause of disease being obscured by their presence. The parasitism of some of the organisms may be doubtful, but their occurrence is considered to be worthy of record in the absence of more exact knowledge.

Phoma zeicola El. *and* Ev. (Plate VIII, fig. B) occurs with other fungi on withered leaves collected at Attabubu and Esiama, and developed in damp chambers on mouldy glumes of staminate inflorescences from Odumase and Asuansi.

PYCNIDIA, scattered, olivaceous-brown to black, spherical, submersed, erumpent by shortly beaked ostiole, 80 to 200 microns in horizontal diameter ;

SPORES, hyaline, 2 to 6 by 1.5 to 2 microns, cylindrical, extruded in mucous tendrils.

Cladosporium herbarum Link, causes a velvety, greenish-grey mould on dead portions of leaves at Ejura and elsewhere.

SPOROPHORES, olivaceous-brown usually pale at apex, septate, erect, frequently keeled, arising from stromatic mycelium, 4 to 110 by 40 to 7 microns, bearing short, sometimes branched chains of spores either apically or laterally;

SPORES, hyaline to light brown, subcylindrical to ovate, either continuous or 1 to 3 times septate, 5 to 18 by 3 to 6 microns.

Clasterosporium maydicum Sacc. (Plate X, fig. B), occurs fairly frequently on the withered portions of leaves in pure colonies surrounded by other fungi, at Aburi, Ejura and elsewhere.

It is recorded under the above name because in its early stage it agrees with Saccardo's diagnosis [17]. Its mature spores are, however, frequently muriform, a fact which makes its position in that genus doubtfully tenable, and one that Saccardo appears to have overlooked, since examination of No. 217 of Baker's Fungi Malayana determined as *C. maydicum*, and which may be taken as authentic material, shows similar muriform spores. A camera lucida drawing of that exsiccatum has been reproduced on Plate X under figure A for comparison with one of the local fungus (fig. B).

SPOROPHORES, short, hyaline, simple, solitary, arising from sub-epidermal mycelium, bearing one spore apically;

SPORES, muricate, at first cylindrical to sub-globose, becoming ovoid to ellipsoid minutely spinulose, with 3 transverse septa, the second or third cell, frequently being divided again by a vertical septum.

Nigrospora sphaerica (Sacc.) Mason in lit.* (Plate X. figs. E. F), has been found on translucent leaf-spots with a diffuse light-brown border at Aburi, and with many other fungi on diseased areas of leaves, such as is shown by figure C of Plate I, at Aburi and Kumasi.

It has been given the above new combination with an extensive synonymy by Mason, who differentiates it from *N. oryzae* (B. & Br.) Petch on account of its larger spore dimensions. He states that cultures of the local fungus match well in size of spores the description of American mycologists of their *Basisporium gallarum* on maize.

Durrell [6] attributes a serious dry-rot of maize to *B. gallarum*, the spores of which average 13 to 18 microns in diameter. In 1923 in the State of Iowa the fungus effected a diminution in the germination of seed sown, and rotted the shanks, husks and stalks of mature plants, the damage done to the crop varying from 9.1 to 50 or 60 per cent. in some fields.

The fungus is not definitely known to cause serious disease in this country, but it is obvious that further investigation on this point is desirable.

The fertile hyphæ of *N. sphærica* are shown in figure F, Plate X arising from the stomata of a translucent leaf spot; figure E of the same plate depicts the fungus as developed on cassava mush agar from the same source.

SPOROPHORES, oblong to ampulliform, 7 to 13 microns in width, hyaline to light-brown, bearing a single apical spore, arising apically or laterally from a fertile hypha of usually swollen segments;

SPORES black, opaque, spherical in horizontal plane, flattened at base, somewhat pointed at apex, 15 to 20 microns in diameter.

*Published, at time of going to press, by E. W. Mason, in Trans. Brit. Myc. Soc., p.158, as *Nigrospora sphaerica* (Sacc.) comb. nov.

Papularia sphærosperma (Pers.) v. Höhnel (Plate X, fig. C), occurs on withered areas of leaves in association with other fungi at Aburi, and has been recorded with no data in a collection made locally by W. H. Johnson under *Coniosporium arundinis* (Corda) Sacc.

It is probably merely saprophytic. Spores and their germination are shown in figure C. of Plate X.

SPOROPHORES, hyaline, straight, simple ;

SPORES, lens-shaped with flattened margin, 10 by 5 microns, dark olivaceous brown, margin appearing in full face view as a paler and more or less translucent zone, and in profile as a translucent band dividing the spore into two plano-convex, darker, portions.

Epicoccum neglectum Desmaz. is recorded on dead portions of leaves collected at Ejura [30. Plate VII.].

SPORODOCHIA, black, pulvinate, arising from stomata of host in a manner suggesting that of the sori of *Hemileia ;*

SPORES, borne terminally on short, stout sporophores, at first oblong to clavate and non-septate, becoming globose, longitudinally septate, then muriform, constricted at septa, brown, somewhat obscurely areolate, 15 to 20 microns in diameter.

DISEASES OF MAIZE INFLORESCENCES AND GRAIN.

Apart from the affection of both staminate and pistillate inflorescences caused by *Ustilago zeæ*, the following diseases affecting the reproductive organs of maize occur locally.

MOULDY TASSELS.
(Prob. Ophiobolus heterostrophus Drech.)

In the damper districts of the maize area there are frequently found male inflorescences, the spikelets of which are matted together by a velvety, greenish-black mould. Figure D. of Plate I shows this condition as compared with normal spikelets. The attack may be sufficiently severe to affect the whole panicle, or only a few spikelets may bear the disease.

Examination shows a heavy infection on the surface of the glumes of a species of *Helminthosporium* which is considered to be the conidial stage of *Ophiobolus heterostrophus* Drechsler. Spores and sporophores from such material are depicted under figure B of Plate V, and others, cultivated on tap-water agar from the same source, under figure D. They do not appear to offer any morphological differences from those of the fungus discussed on p. 14 under Leaf-Spot of Maize.

In most cases that have been examined the stamens have been affected, and their function destroyed by the fungus, so that the damage done by the disease may be considered to have a direct result on yield in proportion to its incidence. The fungus is sometimes accompanied by *Acrothecium lunatum* (p. 16), and by *Phoma zeicola* (p. 23) on mouldy tassels. The disease has been recorded at Aburi, Asuansi, Odumase, Bunso and observed elsewhere.

EAR-ROTS.

A number of fungi are usually found on the dry rotted ears of maize in this country, of which *Diplodia macrospora* Earle described on p. 21 is no doubt pathogenic. In the United States of America, in addition to the ear rot caused by *Basisporium gallarum*, there is a complex group of diseases, comprising root, stalk and ear rots, attributed to a number of fungi that are found on affected material either singly or in combination; they are variously referred to by different workers as *Diplodia zeæ, D. macrospora, Oöspora verticillioides, Fusarium moniliforme, Gibberella saubinetii, Cephalosporium acremonium, and C. sacchari,* and it is alleged, cause more serious damage to maize than any other pathogens in America.

Until more exact investigations have been made locally the relationship between some of the above species that occur here and their effect on the host-plant cannot be definitely stated. The followings notes on their occurence, however, may be useful in indicating lines of future work.

Diplodia Macrospora Earle

As previously stated (p. 22) this fungus is considered by some workers to be a form of *D. zeæ*. It is recorded as an ear-mould of maize that caused heavy damage to the 1923 crop in Florida. A number of cases have been observed in this country, and the organism is described herein on p. 21.

Symptoms.

The illustration (fig F) of an ear-rot on Plate I is that caused by this species. Development of the cob has been arrested, the husks have prematurely withered to a straw colour, and show as a distinguishing character, the minute, but macroscopically visible, black dots caused by the development of pycnidia. In the case of later infections the trouble may not be apparent until the cob is dehusked when a white to greyish mycelium is found massed between the grains.

Effect.

Not only is there a direct loss of crop due to the destruction of ears or grains, but there is a strong suspicion that the mycelium (as is the case of *D. zeæ* in America) permeates the grain and causes loss to the succeeding crop. Moreover *D. zeæ* has been shown to cause paralysis to cattle fed on affected material in S. Africa.

The disease as caused by *Diplodia macrospora* has been collected at Juaso and Ejura.

Gibberella moniliforme Wineland.

There appears to be no doubt that this pathogen occurs here in its conidial stages. Miss Wineland [28] has shown that its microconidia agree in morphological characters with the fungus to which Saccardo gave the name *Oöspora verticillioides*, and that macroconidia, to which Sheldon's binomial *Fusarium moniliforme* should be applied, belong to the same organism. The ascigerous stage does not occur in nature and has only been observed in cultures of mixed strains.

Cultures inoculated in the field from Maize Leaf-spot II, were contaminated by a mould which when separated out and planted on maize seedlings gave typical macroconidia (illustrated under the name *Oöspora* sp. in fig. D, Plate VIII, of [30]).

Macroconidia of a *Fusarium* taken from a rotting maize culm, when used to inoculate a maize seedling also developed the characteristic microconidial stage [l.c. fig. E]. Sub-cultures from both sources have remained distinct, and the evidence afforded by this incomplete investigation is too inadequate to be of value.

Symptoms.

A fairly dense whitish mycelium occurs between the husks and generally infests the ear, while the stalk may or may not be rotted and the leaves withered. A great deal of work on the symptoms and etiology of this group of diseases is necessary before anything of authoritative value can be written on their local significance.

Associated Fungi.

The Fusarium spores measure 30 to 45 by 3 microns, and are from 3 to 5 times septate. The microconidia are borne on simple branched conidiophores which taper gradually to their apices, the spores being hyaline, usually obovoid, basally pointed, from 5 to 13 microns in length, and occurring in chains, or clustered, at the apex of the conidiophore.

EAR-ROT CONTROL.

It is suggested that any attempt to control the development of fungi causing rots in maize should include seed disinfection by heat; seed selection; a 4 to 5 years rotation, and efficient cultivation.

BLACK GRAIN.
(Botryodiplodia theobromæ Pat.).

An unusual affection of harvested ears was observed at Kumasi in 1926 during the dehusking of a crop of Hickory King maize that had been grown on a plot adjacent to cacao. A few cobs were found in which occasional jet-black, or greenish-slatey coloured grains

were interspersed, in groups of one to three, among those of normal colour. The affected grains were normal in shape, but the lighter coloured ones bore a few, scattered, shiny black protuberances on their lateral faces. Examination of a section through the cob revealed a blue-grey discolouration concentrated at the cut end and decreasing in intensity toward the apex of the pith. No sign of disease is said to have been noticed on the husks.

Mycelium typical of *Diplodia,* occurred in the discoloured pith and permeated the affected grains. The sub-epidermal fructifications, of roughly two millimetres diameter, were found to be pseudostromatic, consisting of similar hyphæ, and containing numerous, irregularly shaped, pycnidia, with internal dimensions of about 200 microns diameter and 500 microns height.

The spores, which at first were hyaline, continuous, oblong to oval in shape, were at maturity dark brown, once septate, measured 25 to 34 by 15 to 18 microns, and did not differ from those of *Botryodiplodia theobromæ* Pat. found on cacao.

Cacao pods, inoculated by incision with the mycelium either directly from black grains or from cultures, produced typical Diplodia pod-rot in about a week, and frequently, the fructifications of *B. theobromæ.*

It was apparent that infection of the ear had occurred at the cut surface of the shank.

C.—DISEASES OF GUINEA CORN.

So far as the author is aware the botanical position of this host-plant, or plants, has not been definitely determined. It is possible that several species that are now considered distinct [31 : p. 801], occur locally, and have in the past been grouped under the old binomial *Andropogon sorghum* Brot. (*Sorghum vulgare* Pers.)

As a crop Guinea corn or sorghum is not so extensively cultivated in the Gold Coast Colony as in the Northern Territories and some districts of northern Ashanti. For this reason its diseases have not been so closely observed as have those of maize. Of such as have been recorded, the grain-smut is probably the most destructive, many of the foliar diseases attacking only such leaves as have fulfilled their function.

GRAIN SMUT.

(Sphacelotheca sorghi (Link.) Clinton).

This disease did extensive damage to a large farm of Guinea corn at Ejura in 1924, and is said always to be present in that district, it has also been received from the Northern Territories.

Grain smut is recorded for practically all countries where the host crop is cultivated, and causes considerable losses, for example it is estimated to destroy annually in the State of Kansas, grain to the value of $2,000,000, and Butler [2 : p. 210] states that the value of the grain lost annually in India must amount to several millions sterling.

Symptoms.

The characteristic feature of Guinea Corn grain smut is the replacement of individual grains by spore sacs which, in all cases seen, consists of elongated, oval, greyish-black sacs full of dark coloured spores and enclosed by the normal glumes of the host-plant. Two smutted grains are illustrated (natural size) under figure B of Plate XI. Under the same figure may be found a section through one of the grains, enlarged four times, to show the columella that consists of tissue of the host-plant and persists after the dispersal of the spores.

Infection.

It is apparent that by the rupture of a spore sac a large number of spores are liberated which by attachment to grain subsequently used for seed, are potential pathogens.

Infection of a new host takes place immediately after the germination of the seed, and is said chiefly to occur by the mesocotyl. No visible effect of the presence of the fungus appears

until the ears are formed. Kulkarni [7] has shown in India that atmospheric temperature at the time of the germination of Sorghum seed is an important factor in determining the incidence of grain smut; by laboratory tests and field experiments using seed mixed with spores he obtained negative results at temperatures ranging from 36° to 40°C, and over 50 per cent. infection at a temperature of 25°C. Butler [2 : p. 210] also states that the optimum temperature for the germination of the spores of *Sphacelotheca sorghi* is from 20° to 30° C, and that although they may maintain their vitality for some years if kept dry, they germinate readily in moisture.

It is improbable that infection takes place by spores left in the soil from a previous crop unless a continuous spell of sufficiently dry weather has prevented their germination.

Control.

The facts that infection occurs only at the germination of the seed, and that it is usually caused by spores adhering to the seed, make seed disinfection particularly successful in dealing with this disease. Soaking the seed in a 2 per cent. solution of copper sulphate for 10 to 15 minutes, or in a $\frac{1}{2}$ per cent. solution of formalin for 1 to 2 hours with subsequent rapid drying, are advocated as effective methods.

Causative Fungus.

The spores of *Sphacelotheca sorghi* may germinate either by a promycelium of four cells each bearing a spindle-shaped sporidium, or directly by a branching germ tube, or by intermediate methods. The sporidia may produce either germ tubes or long branching chains of secondary sporidia. Infection is accomplished by the entry of a fine hypha produced either by a sporidium, or by the promycelium of a spore, and a mycelium is formed at the growing point of the seedling. When the ear begins to form the mycelium concentrates in the immature ovary, forms the membrane of the spore sac, and gives rise internally to the spore mass. The spores are frequently united in masses which break up into individual spores upon the application of water.

SORI,	produced, within the immature ovary of the host, elongated into an oval or conical, greyish, spore sac of about 10 by 4 to 5 mm. dimensions, surrounded by the normal glumes of the host :
SPORES,	round, smooth, dark brown to black in mass, olivaceous brownindividually, 6 to 8 microns in diameter.
IN	the ovaries of *Andropogon sorghum* Brot. Ejura and the Northern Territories.

RUST.

(Puccinia purpurea Cke.)

The disease is usually prevalent on the older leaves of Guinea corn at Ejura. It is very generally distributed, and frequently

reported as the commonest rust disease of cultivated crops, in those countries where sorghum is grown. There is, however, some doubt as to the amount of loss it causes.

Symptoms.

In common with other pathogens which affect the leaves of sorghum, *Puccinia purpurea*, by causing the death of host tissue in its immediate neighbourhood, produces a reddish purple change in the normal colouration of the plant juices. These areas of discolouration, although small, may by their quantity cover a considerable area of the affected leaves. Small, somewhat elongated, brown pustules are produced chiefly on the under side of the leaf, either scattered or in groups.

Causative Fungus.

Puccinia purpurea Cke. (*Uredo Sorghi* Fckl. not *P. sorghi* Schw.) is said to occur on other hosts, including *Andropogon halepense*, and it is possible that the *Puccinia* sp. on *Andropogon gabonense* Stapf. illustrated under fig. E of Plate IX may prove to be this species.

Only the uredinial stage of *P. purpurea* has been observed on Guinea corn material from Ejura. The sori, which are rarely more than one millimetre in length, are at first covered by the epidermis of the host and are occasionally found to be parasitised by *Darluca filum*.

UREDOSPORES,	ovate or elliptic, yellowish brown, 37 to 45 by 26 to 32 microns indistinctly spinulose;
PARAPHYSES,	irregularly clavate, light brown, frequently contorted, with walls, up to 11 microns thick at apex.
ON	foliage of *Andropogon sorghum*, Ejura.

LEAF-SPOTS OF SORGHUM.

I.—(Colletotrichum andropogonis Zimm. [29 : pp. 13–15.])

Of the two common leaf-spot diseases, which differ from Sorghum rust in not being pustular, that caused by the above parasite may usually be differentiated by the small size and discrete occurrence of its reddish-purple spots.

The disease is prevalent on old leaves, but does not appear seriously to effect the yield of grain owing to late infection.

Causative Fungus.

It is probable that *C. graminicolum* (Westd.) Wilson is synonymous with Zimmermann's species ; the spores and a seta of the local fungus are figured on Plate VIII. fig F.

SPORES,	falcate, hyaline, 23–28 x 4–5 microns
SETAE	cylindrical, bulbous at base, rounded at apex, dark-brown almost hyaline at apex, septate, 140 x 5 microns.
ON	foliage of *Andropogon sorghum*, Ejura.

II.—(Cercospora sorghi E. and E.)

The tendency of Cercospora infections on Guinea corn foliage to elongate from small, purplish-red spots, and to coalesce, until an affected leaf presents but small and inconsiderable areas of normal coloration, is probably of greater diagnostic value than is the somewhat darker and duller discoloration produced by this fungus when compared with the effect of *Colletotrichum andropogonis*. The spots as they increase in size develop a clearly defined, buff or straw coloured, central portion which may be up to 9 cm. in length and 3 mm. in width, with a dull, dark purplish red, rather wide, border.

The disease occurs on old foliage in such profusion as to provide the source of a dye for some of the natives of the Northern Territories. Its effect on young plants is said to be almost negligible.

Causative Fungus.

Reference to figure C. of Plate VIII (drawn from Guinea corn leaf spots) shows short, 1 to 3 septate, spores that approximate to those of *C. Köpkei Krüg.*—a species recorded only for *Saccharum* sp.—together with longer, up to 7 times septate, spores which are in closer agreement with the description of those of *C. sorghi* E. and E. Both forms have been found to occur on the same spots on Guinea corn, and on similar spots on *Andropogon halepense*. Prof. Ashby (in lit.) has also recorded both forms as occurring on *A. sorghum* in Uganda. It is probable that both the shorter and the longer spores should be regarded as *Cercospora sorghi*, but neither has been subjected to cultural tests, nor is the degree of affinity between that species and *C. Köpkei* known.

SPOROPHORES, geniculated, hyaline when young, becoming fuscous later, 20 to 80 by 3 to 6 microns.

SPORES, tapering abruptly at base to a conspicuous hilum and gradually toward apex, straight or curved, hyaline, 1 to 7 times septate 20 to 84 by 2 to 6 microns.

ON leaves of *Andropogon sorghum* and *A. halepense*, Trom, Somanya, Ejura.

MOULDY INFLORESCENCES.

Mature inflorescences of Guinea corn have been found bearing copious growths of the fungus described under *Acrothecium lunatum* Wakk. (p. 16).

The occurrence is regarded as symptomatic of uncongenial conditions rather than as the actual cause of disease. An apparently similar condition is recorded for *Acrothecium lunatum* on Sorghum in the East, where it is likened to that caused by *Cladosporium*.

No noteworthy difference was obvious between the organism on this, and on other, host-plants found locally.

D.—DISEASES OF BULRUSH MILLET.

As is the case in Guinea corn, the local diseases affecting Bulrush Millet (*Pennisetum typhoideum* Rich.) have not been closely observed owing to the fact that the crop is but rarely cultivated in the forest areas of the Gold Coast. As a crop the host-plant does not appear to be so universally cultivated as other cereals, and consequently fewer diseases are recorded; Butler [2 : p. 218-226] gives three for India, the smut, green-ear disease, and rust, to which reference is made below.

SMUT.

(Tolyposporium penicillariæ Bref.)

The occurrence of bulrush millet smut in this country has been recorded for Tamale and Ejura, and occurred recently on a few plants grown, for experimental purposes at Aburi, from seed obtained at Ejura. At the latter place it is known to have caused a loss, of about one third the number of harvested ears on a small plot in 1926, and may be considered as a serious disease likely to increase in severity by the indiscriminate use of seed taken from diseased ears.

Butler stated in 1918 [2 : p. 224] that " outside India, it has not been definitely identified but appears to occur in Egypt and possibly in other parts of Africa ".

Symptoms.

The disease is readily detected by the presence of smutted ovaries which may be scattered either singly or in small groups, and are distinct from the normal grains by the bright green, brown or black colour of their membrane and by their longer development which projects them beyond the surrounding glumes. These grains are composed of a pear-shaped or oval sorus of brown to black masses of spores enclosed in a hypertrophied membrane of host tissue. Figure D of Plate XI shows two affected grains in situ drawn natural size; in immature ears, the symptoms of smut are more distinct than in those shown, individual infections being sharply demarcated from the background of undeveloped fruits by the conical bright green to black, projecting sori.

Causative Fungus.

Tolyposporium penicillariæ resembles the smut referred to on p. 29 as affecting Guinea Corn in its effect upon individual florets, but differs from that fungus by bearing its spores in tightly compacted masses that do not readily break up in water, and by having no columella.

McRae [9] reported in 1922 that the mycelium had been found in apparently healthy grains occupying the scutellum and seed-coat near the embryo. So that it is apparent that the disease is carried by the seed. Control measures should therefore consist of the selection of seed derived from known healthy parents, and seed disinfection by hot water should be attempted.

SORI,	produced within the ovary of the host, pear-shaped to oval with conical or rounded apex, up to 6 microns in length by 4 microns wide, enclosed in bright green to dull black membrane.
SPORES,	compacted in masses, 80 to 100 microns in diameter, round or angular with a light brown, thick wall irregularly roughened on free surface ; 8 to 11 microns in diameter.
IN	the hypertrophied ovaries of *Pennisetum typhoideum*, Ejura and Tamale.

SUGARY DISEASE.

(Sphacelia sp.)

Two mature ears of Bulrush Millet were received from Tamale in 1925, which bore, scattered among the normal grains, dried, black, sticky exudations that had apparently arisen from infected ovaries. Capt. Beal—to whom the author is indebted for the material—described the disease as " a kind of smear spread over the outside of the millet head ", and stated that " the natives attribute toxic properties to this parasite ; they say that, when millet thus affected is ground into flour and eaten, it tastes sweet like honey, and then it causes the stomach to swell and also makes a person feel drunk. "

The disease occurs in Tanganyika where it is known as " Asali ", and is probably the condition to which Zimmermann referred in 1904 [29 : p. 16] as an undetermined sclerotial growth in the ovaries of *Pennisetum spicatum*, such as precedes the development of a *Claviceps*.

The fungus has also been recognised as occurring in the South Kordofan district of the Sudan.

Causative Fungus.

Sphacelia sp. stromata occupying the position of grain are shown (natural size) in figure E of Plate XI. Such as have been examined were found to be somewhat longer than the mature grains, they were more or less conical in shape, convoluted externally, and bearing on the surfaces of the folds simple conidiophores arranged in palisades with single-celled, hyaline spores. The

stromata occasionally included stamens and other floral organs of the host either embedded in their tissue or closely adherent by means of a sticky exudation, which was also in some cases infested by a *Cladosporium* sp.

It is possible that the fungus may be identical with the *Sphacelia sorghi* of Indian mycologists, the cause of Sugary disease of Sorghum. Attempts to obtain the ascigerous stage by cultural methods have not been successful, and it is therefore impossible to arrive at a critical determination. Small [19 : pp.15-16] reports the occurrence of a *Sphacelia* on the ears and stems of *Pennisetum typhoideum* and *P. purpureum* Schum. in Uganda, which differs from that now under discussion by its larger, woody stromata, and is probably identical with the fungus described on p. 42 as a Sphacelia sp. on *Andropogon Gayanus* var *bisquamulatus*.

SPOROPHORES,	simple filiform, bearing a single spore apically.
SPORES,	hyaline, oblong tending to boat-shape, containing several oil globules, 11 to 22 by 2.5 to 4 microns;
IN	hypertrophied florets of *Pennisetum typhoideum*, Ejura and Tamale.

GREEN EAR DISEASE.

(Sclerospora graminicola Schroet.)

This disease has been reported as affecting bulrush millet in the Northern Territories, where it is said to be common on individual plants though never to assume epidemic proportions.

It occurs in India and East Africa, and the causal fungus is pathogenic to other host-plants of economic importance in Europe, India and the United States of America.

Symptoms.

The effect of the parasite upon the ears of an affected plant is strikingly conspicuous, somewhat suggesting to casual observation the effect of general vivipary ; the ear is converted from the normally compact spike of flowers or grain into a loose, green, head of small, twisted leaves.

The presence of the fungus may also be indicated by white or brown, elongated areas in the leaves of the host.

Causative Fungus.

As in other species of the genus *Sclerospora*, the sporangial stage of *S. graminicola* Schroet. is evanescent, and is succeeded by abundant production of oöspores. These spores have highly resistant walls, and it is thought probable that it is by them that the parasite is carried over from one growing season to another in spite of the fact that efforts to induce their germination by laboratory methods are reported as unsuccessful.

Control.

It is suggested that a sufficient control of green-ear disease can be maintained by the eradication and destruction of infected plants.

RUST.

(Puccinia penniseti Zimm.)

A rust occurred in profusion on a few plants of *Pennisetum typhoideum*, grown for experimental purposes at Aburi in 1925. The facts that the disease has not yet been recorded for the source of origin of the seed, and that its only occurrence was on old and weakly developed plants which were grown under conditions not considered as ideal for the crop, do not indicate that it is a serious trouble. Its occurrence is of interest, however, as it does not appear to have been previously recorded for West Africa, nor for any other countries than India and East Africa.

Symptoms.

Small, elongated, pustular spots of an orange colour occur chiefly on the upper surface of the leaves, and on the stems, and assume a powdery appearance by the discharge of uredospores, later teleuto-sori are formed similar to those of the uredinial stage, except that they are from brown to nearly black in colour.

Causative Fungus.

Puccinia penniseti Zimm. (Plate IX, fig. A).

AECIDIAL STAGE not known.

UREDINIAL STAGE, sori amphigenous, numerous, sometimes confluent, pustular; spores oval or pear-shaped, yellow, spinulose, 28 to 41 by 23 to 30 microns, borne on hyaline stalks, 20 to 32 by8 to 10 microns;

TELEUTOSPORES, cylindrical to elongated oval, basal cell being much the longer, round or flat at apex, restricted at septum, with apically thickened wall, orange brown, smooth, 46 to 70 by 20 to 25 microns, borne on short, usually colourless stalks, 18 to 30 by 8 to 10 microns;

ON foliage and stems of *Pennisetum typhoideum* Rich., Aburi.

LEAF SPOT.

(Helminthosporium sp.)

Irregular spots 10 to 40 mm. in length, at first sepia in colour, becoming translucent with a narrow brown border and up to 11 mm. in width, have occasionally been found on bulrush millet at Aburi. When young the spots are coated on both surfaces by a velvety outgrowth consisting of brown sporophores.

Associated Fungus.

The unidentified species of *Helminthosporium* shown under figure E of Plate VII occurs on these spots. It produces from a somewhat torulose mycelium, simple sporophores in groups of one to six through the stomata. No ascigerous stage was found.

SPOROPHORES, cylindrical, 2 to 5 times septate, brown with hyaline apex, up to 150 microns in length and 5 microns in width;

SPORES, ellipsoidal, tapering more abruptly to proximal, than distal, end, straightor slightly curved, fuliginous, 6 to 12 times septate, 38 to 122 by 13 microns;

ON leaves of *Pennisetum typhoideum* Rich., Aburi.

E.—DISEASES OF RICE.

Rice, although imported in considerable quantities, is not generally grown as a staple food-crop on the Gold Coast: except for certain parts of the Northern Territories, and the south-western district of the Colony, the crop only occurs in isolated patches where it is cultivated by settlers from other countries.

Such diseases as are known to occur locally are not usually serious—a possible exception being those caused by *Piricularia oryzæ*.

BLAST.

(Piricularia oryzæ Br. and Cav.)

In 1922 the rice crop at Adebrem was threatened with considerable loss by the occurrence of the above fungus which is known in other countries as the cause of this destructive, and sometimes epidemic, disease; the attack was, however, checked by a dry spell of weather and has annually recurred with varying amount of damage. It has also been collected subsequently at Asuansi, Juaso and Ejura. Its presence was usually apparent in connection with leaf-spots, but at Essiama it has more recently been found on the upper part of the stem resulting in the destruction of the neck with consequent loss of grain.

The disease occurs universally wherever rice is cultivated, and has been known in Italy for many centuries; it is regarded as the most serious disease affecting rice.

Symptoms.

The evident effects of the presence of *Piricularia oryzæ* on rice plants may differ according to the severity of attack and to the age of the host at time of infection. Small brown spots, which develop into ashen grey areas of considerable size with an irregular brown border, occurring on the leaves, have up to the present been the most common manifestation locally. Natural recovery by tillering, consequent upon climatic conditions that were adverse to the development of the pathogen, has been observed in young plants, but, failing such conditions the effect of the fungus was more or less similar to that of malnutrition.

In other cases where infection had taken place later in the life of the host, the upper nodes of the stem, or the pedicels, were attacked, the affected areas being brown in colour and becoming shrunken by the destruction of internal tissue; such infections frequently resulted in the collapse of the head from the point of attack.

Control.

In the present stage of our knowledge regarding the life history of the fungus causing rice blast, no other measure to control the disease appears to be practicable than to provide the most favourable conditions for the vigorous growth of the host plant by cultivation and general sanitation methods. Local research is needed to ascertain how infection occurs, whether seed disinfection would provide an efficient and economical method of control, what other hosts of the parasite occur, and whether permanently resistant strains of rice could be obtained by breeding.

Causative Fungus.

Piricularia oryzæ Br. & Cav.) Plate VIII. fig. D. Small [19 : pp. 16 and 17] by experimental work in Uganda ascertained that rice-blast can be caused by *P. oryzæ*, to which parasite the disease is usually attributed by other workers. The fungus is morphologically indistinguishable from *P. grisea* (Cke.) Sacc. a parasite on *Digitaria sanguinalis*, but from work in India [9] it would appear that the two specific names represent biological strains. No ascigerous stage of the fungus is known, but the viability of the conidia has been shown by Sundararaman [21] to be effective after 5 months of dry storage, usually a sufficient period to tide over a dry season.

SPOROPHORES,	pallid, usually simple, 2 to 5 times septate, about 120 by 4 microns arising in groups of 1 to 5 from the stromata ;
SPORES,	obovate with distinct hilum, twice septate, 18 to 33 by 10 to 11 microns.
ON	leaves and stems of *Oryza sativa*, Adebrem, Essiama, Asuansi, Juaso, Ejura.

BROWN LEAF SPOT OF RICE.

(Helminthosporium oryzæ van Breda de Haan.)

A very prevalent disease on rice growing under unsatisfactory conditions has been found on one or two occasions in Ashanti and at Aburi. In one case a fairly large farm was examined and practically every leaf of the half-developed crop found to be heavily infected. In another instance, rice grown on land which had borne the same crop during the previous four years, showed abundant symptoms of the brown leaf-spot. Other collections have been made from rice grown in an unsuitable environment and from self-sown seedlings that had developed out of season.

The disease is said to be of universal occurrence, and to be particularly severe in its attack upon young seedlings—a mortality from 10 to 58% having been reported among seedlings in the Philippines for 1918 and 1919 [12], whilst in Japan the incidence of the disease may be so high as to make it difficult sometimes to find a seedling entirely free [4 : p. 727].

Symptoms.

The leaf spots are at first minute and warm brown in colour, they increase in size principally in a longitudinal direction until they attain a length up to 4 mm; in this later stage they may become lighter or even an ash grey colour in the centre; in their early stage many show a tendency to irregular zonation. Sporophores are formed chiefly on the lower side of the leaf and tend to spread beyond the limits of the spots when the latter are sufficiently prevalent to cause the death of the intermediate tissue.

Control.

Ocfemia [12] states that the causal organism is carried over from one season to another as dormant mycelium on the seed, a fact which accounts for the good results obtained by workers in Japan in their attempt to control the disease by the hot water treatment of seed. Immersion for ten minutes in water heated to 52° C., or for five minutes in water at 54° C., after the seed has been soaked in water at atmospheric temperature for 24 hours has been recommended. It must be borne in mind, however, that the fungus has been proved to be infective to many other species of grasses, and that the sterilisation of seed without clean weeding might not be effective.

Causative Fungus.

Helminthosporium oryzæ B. de H. (Plate VII, figs. A-D). Van Breda de Haan described the fungus in 1900 as causing a leaf-spot on rice in Java, and Miyabe and Hori gave the same name to the same fungus in Japan in 1901. It has been confused in Italy with species of *Piricularia* and with other species of *Helminthosporium* as being one of the causes of the condition known as the brusone disease of rice.

As in some other species of the genus, the conidia differ considerably in size according to the substratum on which they develop, a fact which may be illustrated by a comparison of the spores shown under figures A, B, and D from leaf spots, with those figured under C from affected seed. No ascigerous stage is known.

The conidia upon germination adhere to the surface of their host by means of appressoria formed by the swelling and branching of the tip of the germ tube; from these structures infective hyphæ either penetrate the cuticle direct or enter by means of the stomata.

Ocfemia [13] found in the Philippines that the conditions favourable for the germination of rice seed and for the sporulation of the fungus were nearly the same.

SPOROPHORES,	brown to an almost hyaline apex, sometimes branched from the base, slightly constricted at the septa, inconspicuously geniculated, up to 350 by approximately 7 microns;
SPORES,	fuliginous, tapering towards a slender apex, rounded basally, with included hilum, curved, 55 to 108by 13 to 20 microns, 5 to 9 times septate; germination bipolar;
ON	the foliage of *Oryza sativa*, Ejura, Juaso and Aburi.

MOULDY INFLORESCENCES OF RICE.

(Helminthosporium oryzæ van Breda de Haan.)

Another manifestation of the activities of *Helminthosporium oryzæ* has been collected at Adebrem and Aburi, in which the panicles bear numerous, but scattered, spikelets that are conspicuously differentiated by the presence of dark brown spots of varying size.

No observations have been recorded as to the amount of crop lost by this disease, but the fungus has been found to infest all parts of a spikelet, with the result that empty glumes occur in a ripe head of grain.

The probable relationship of this affection with the brown leaf-spot also requires investigation, but the fungus, save for the facts that its spores (see Plate VII. fig. C) are of more generous dimensions (93 to 140 by 15 to 20 microns), and that they arise from a mat of superficial hyphæ, does not differ from the *Helminthosporium oryzæ* of the brown leaf-spot.

Acrothecium lunatum (Plate VI. fig. F.) sometimes occurs in association with the above fungus on mouldy rice spikelets, in the same way that it is found on similar affections of maize.

NIGROSPORA ORYZÆ ON RICE.

Scattered groups or single examples of the sporophores of *Nigrospora oryzæ* (*B.* & *Br.*) Petch have frequently been found during the examination of rice foliage for possible pathogens. The sporophores have sometimes been seen to arise through the stomata of apparently healthy material, and in none of the cases examined has definite evidence been found of the fungus being the cause of a pathological condition on rice leaves. On the other hand, the fungus has been found in one collection in abundance on all parts of immature rice spikelets strongly suggesting that its presence accounted for the barren heads. The glumes were discoloured either completely or by grey areas, whilst the withered reproductive organs were infested by a white to fuliginous mycelium bearing scattered spores.

Associated Fungus.

Nigrospora oryzæ (B. & Br.) Petch (Plate X, fig. D). Mason (in lit.)* gives an extensive synonymy for this species, including the smaller spored form of *Basisporium gallarum*.

Local examples are similar to the N. sphærica found on maize (see p. 24) but differ in having smaller spores which when young are lighter in colour.

SPOROPHORES, oblong or ampulliform, fuliginous or hyaline, usually arising in groups from hyphae of short swollen segments;
SPORES, brown to black, spherical in horizontal plane, 10 to 18 microns in diameter;
ON leaves and spikelets of *Oryza sativa*, Aburi, Adebrem, Essiama.

*Published, at time of going to press, by E. W. Mason, in Trans Brit. Myc. Soc. XII, p. 160.

F.—DISEASES OF SUGAR CANE.

Sugar cane is not grown as a commercial crop in the Gold Coast Colony. It is planted in usually very small patches and used merely for local consumption in its raw state rather as a sweetmeat than as a staple article of diet.

The following diseases have been noticed.

RING-SPOT.

(Leptosphæria sacchari van Breda de Haan.)

This disease, common in practically all cane countries, occurs generally where the crop is grown. It attacks the older leaves, and whilst it is possible that some loss to the host may result, severe damage is infrequent.

Symptoms.

Small purplish-brown spots appear on the leaves usually toward the edge and extend to form long (3 by 1 c.m.), oval or acutely irregular, straw coloured spots with a markedly distinct border of purplish-brown. Frequently the affected areas of the leaf assume an orange-yellow discoloration in patches which tone off to normal green. The spots occur in large numbers and are visible on both sides of the leaf.

Control.

The disease is not considered of sufficient importance to warrant special preventive measures being adopted. It is said that some varieties of cane are much more susceptible to attack than others, and that moisture conditions predispose such varieties of cane to the disease.

Causative Fungus.

Leptosphæria sacchari B. de H. (Plate VIII. fig. H.)
Fructifications of the fungus may be visible on the upper surface of an affected leaf as very small black dots on, or less frequently beyond, the spots; they are the perithecia shown in fig. H. of Plate VIII.

A conidial stage, of which the spores are described as curved and thrice septate, has sometimes been ascribed to this fungus as the actively infective agent. It is possible that the incidental occurrence on ring-spots of the fungus described on page 16 as *Acrothecium lunatum* accounts for this assertion.

PERITHECIA, spherical, light brown, thin walled, immersed, ostiolate 100 to 170 microns in diameter, scattered on upper surface of leaf;

ASCI, clavate, containing 8 spores in 2 or 3 rows.

ASCOSPORES, colourless or becoming light brown, 3 times septate, central cells wider than those at ends, constricted at septa, elongate straight, 18 to 25 by 5 to 7 microns;

ON leaves of *Saccharum officinale* L. at Aburi and elsewhere.

OTHER FUNGI FOUND ON SUGAR-CANE.

Helminthosporium sp. An undetermined species of *Helminthosporium*, the apparent cause of buff, elongated areas of discoloration, which measure up to 20 cms. in length and are surrounded by a narrow, purplish border, has been collected on young leaves of sugar-cane at Asuansi. The fungus differs from Butler's *H. sacchari* [2 : p. 408] by its much larger spores; it produces a black, mouldy appearance on the withered centres of the affected areas by the development of its sporophores which arise, frequently in pairs, from stromatic masses of dark mycelium.

SPOROPHORES, brown with hyaline apex, thick walled, geniculated, 6 to 8 times septate, up to 145 by 5 to 6 microns;

SPORES, fuliginous, straight or slightly curved, almost cylindrical, thickest at or below middle, tapering gradually to both ends, with conspicuous hilum, 7 to 11 times septate, 38 to 148 by 13 to 16 microns with bipolar germination.

Acrothecium lunatum Wakk. occurred in profusion with the preceding *Helminthosporium* and presented no essential difference from the fungus described on p. 16. It is illustrated by Plate VIII, fig. B. of the G.C. Dept. of Agric's. Year-book 1926.

Nigrospora sphærica (Sacc.) Mason. This fungus, referred to on p. 24 as occurring on Maize foliage, has been collected on withered areas of sugar-cane leaves in small colonies. Its spores averaging about 6.5 microns in diameter preclude it from the larger spored *N. sacchari* (Speg.) Mason.

G.—UNCULTIVATED HOST-PLANTS.

Some of the following fungi found on wild graminaceous, or allied, host-plants are of interest.

ANDROPOGON GABONENSE STAPF.

This grass is commonly affected by a rust which is illustrated by figure E. of Plate IX. The fungus bears resemblance to *Puccinia purpurea* Cke. the causal organism of rust on several varieties of sorghum.

UREDOSPORES, light yellow, ovate, spinulose, 25 to 30 by 20 microns, accompanied by numerous, irregularly clavate paraphyses with much thickened apical cell-wall, 40 to 50 by 12 microns.

TELEUTOSPORES, red-brown, broadly elliptical, with rounded base and apex smooth, scarcely constricted at septum, wall uniform in thickness, 35 to 40 by 26 to 28 microns.

ANDROPOGON GAYANUS VAR. BISQUAMULATUS HACK.

The most interesting fungus found on this host is a sclerotial outgrowth that frequently occurs on the leaves or stem, and is considered to be a *Sphacelia*.

The earliest symptom of attack is the presence of insects and sooty moulds attracted to the affected parts by a saccharine exudation. A sclerotium, internally almost white with an external leathery, brown to black surface follows, and, usually by its development as a crescentic cushion, bends the leaf or stem into an acutely recurved position. The surface of the sclerotium is divided longitudinally and transversely by fissures into a number of rectangular, flat protuberances, thus presenting a muricate appearance. Sections through sclerotia at this stage usually show narrow, convoluted sinuses penetrating to half the depth of the sclerotia and filled with a mass of small (5 to 10 by 2 microns), hyaline, cylindrical conidia borne on simple sporophores.

Later in the year, light buff excrescences may develop on the sclerotium, and bear catenulate, thick walled, ovate, hyaline, apiculate spores which measure 10 to 14 by 8 to 10 microns, on simple clavate sporophores which are characterised by the thickness of their walls at the apical end, and by the abrupt, sometimes angular constriction at the usually elongated point of insertion; they measure approximately 50 microns in length by 7 microns at the upper end, and 4 at their base, in width.

It is possible that this fungus is distinct from those considered to be *Sphacelia;* it may possibly prove to be related to the genus *Langloisula,* published by Ellis & Everhart, in 1889 (Journ. Myc., 5, pp. 68-9).

ANDROPOGON HALEPENSE BROT.

The fungi referred to *Helminthosporium turcicum* Pass. on p. 12 as occurring in leaf blight of Maize, and to *Cercospora sorghi* E. & E. on p. 31 as causing a leaf spot on Sorghum, have both been found associated with leaf disease of this indigenous variety of sorghum.

IMPERATA ARUNDINACEA CYR. (LALANG).

A rust caused by *Puccinia rufipes* Diet. (Plate IX. fig. F.) frequently occurs on the older leaves of this weed.

UREDOSPORES, light yellow to brown, ovate to rotund, sometimes elongate, spinulose, with 4 germ-pores, 22 to 35 by 19 to 27 microns; paraphyses numerous, irregularly clavate or capitate, arising from slender base, with much thickened wall at apex;

TELEUTOSPORES, brown, elliptical to irregularly ovate, sometimes contorted, constricted at septum, smooth, 24 to 37 by 18 to 22 microns.

The uredosori of *Puccinia rufipes* on lalang are frequently parasitised by *Darluca filum* (Plate VIII, fig. E).

In some cases, an ascomycete with black, thin-walled, globose or papilloid, ostiolate perithecia, averaging 100 to 130 microns, has been found associated with *Darluca filum* in the sori. Its clavate, almost cylindrical asci, measure 52 to 74 by 8 to 10 microns, and contain eight hyaline, fusiform, bicellular, spores, which are constricted at the septum, usually less pointed at one end than the other, and are enclosed in a mucilaginous capsule. They germinate at each pole, and cases have been found in which germination had started before the spores were liberated from the ascus.

MELINIS MINUTIFLORA BEAUV.

The only parasite recorded locally for the recently introduced Efwatakala grass is an undetermined species of *Sclerotium.*

MARISCUS UMBELLATUS VAHL.

The inflorescences of this sedge are sometimes parasitised by a smut which usually affects the ovaries. The fungus agrees in essentials with those species of *Cintractia* that affect Cyperaceous hosts. It has somewhat, flattened, oblong to ovate, more or less angular, spinulose, light brown, spores that measure 10 to 12 by 7 to 9 microns, and is considered to be *Cintractia axicola* var. *minor* Clint.

PANICUM MAXIMUM JACQ.

Smut.

The ovaries of this indigenous fodder-grass are frequently infected by *Ustilago heterospora* Henn. (Pilze Ostafrika, p. 48.) The affection may be easily recognised by the green, hypertrophied,

ovaries of about 6 by 4 mm. in size, which take the place of normal florets in more or less profusion. The fungus is illustrated by figure C of Plate XI, and is widely distributed throughout Africa on this host. The smut pustules contain large numbers of short, usually three-branched, sporogenous hyphæ which, in addition to their normal function, appear able to form either sporidia by abscission or to develop hyphal outgrowths when placed in a nutrient medium. They are frequently dispersed with the ripe spores, and may serve as a secondary means of reproduction. The spores are light to dark brown, globose, with a thick epispore and vary from 9 to 20 microns in diameter.

Mouldy Inflorescences.

During wet weather the inflorescences of *Panicum maximum* are frequently affected by a *Fusarium*, which may, or may not, be associated with the above smut. Dr. Wollenweber, to whom the fungus was referred, considered it as a form of *Fusarium heterosporum* Nees on account of the carmine red colour of its stroma, and it may be cited as *F. heterosporum* Nees *forma one* Wollenwr. (lit.). The fungus is widely distributed on this host in Africa, and has been recorded as *F. paspalicola* Henn. Its spores are shown in figure *K* of Plate VIII.

F. heterosporum is recorded as affecting *Pennisetum typhoideum* on the Krobo Plains by a collection made by W. H. Johnson (No. 42.) in 1899.

Leaf Spot.

The *Phyllachora* which causes round to elliptical black spots up to 5 mm. in length, on either side of the leaves of *Panicum maximum* appears to agree with the description of *Phyllachora heterospora* P. Henn. *apud* de Wildeman [27 : p. 362] as revised by Theissen and Sydow (Anns. Mycol. XIII, p. 453-4, 1915). It is illustrated by figure J of Plate VIII, and may be described as follows :—

STROMATA, amphigenous, numerous, round to elliptical, about 1 mm. in diam. convex in transverse section, occasionally confluent, loculi fairly numerous, flask-shaped or distorted by compression, ostioles elliptical, 90 to 130 microns in width by 110 to 170 microns in height;

ASCI, cylindrical to clavate, with 8 spores arranged in two rows, 58 to 80 by 12 microns;

ASCOSPORES, hyaline, elliptical, with rounded ends, continuous, 12 to 15 by 7 to 9 microns.

(Johnson (No. 184) collected a *Phyllachora* on "Arundo?" in 1901, and recorded it as being near *Ph. graminis*. Only a scanty drawing of this collection remains which seems to indicate that the fungus may be referred to the above species.)

PENNISETUM POLYSTACHYUM SCHULT.

A fungus found to be infesting the ovaries of this host is illustrated by figure A of Plate XI. In appearance its effect resembles macroscopically that of a smut owing to the replacement of the normal organs by a brown to black stromatic mass. As is indicated by the drawing, the stroma is strongly convoluted; it consists internally of hyaline hyphæ with an external layer of dark, thick walled hyphæ which give rise to the superficial pedicillate spores. The latter are formed by a primary transverse division of the swollen apices of the pedicels, and become up to six-celled by subsequent division in any plane; each cell becomes irregularly globose, 5 to 11 microns in diameter, and at maturity is capable of germination.

The fungus agrees with the description of *Cerebella cenchroidis* Subram. [20: p. 206], parasitic on *Pennisetum cenchroides* and *Cenchrus biglorus* in India.

ROTTBOELIA EXALTATA L.

Rust.

Two collections from different localities have been made of a rust of this host-plant which might be regarded as *Puccinia Rottboeliæ* Sydow [22 p. 800], described as affecting *Rottboelia arundinacea* (a synonym of *R. exaltata*) in Abyssinia, except that the apex of the teleutospores has not been found to be more than 4 microns in thickness, whereas in Sydow's species it may be up to 10 microns. It is possible that this character may prove to be variable as is indicated in Arthur's synonymy [1. pp. 176-8] for the closely related species—*Puccinia levis* (Sacc. & Bizz.) Magn.

The teleutospores of the local fungus are frequently inserted laterally as is shown by figure B of Plate XI. This again is a variable character and marks a transition to the genus *Diorchidium* Kalchbr.

UREDOSORI, epiphyllous, scattered or in small longitudinal clusters, sometimes confluent, tawny (Ridgway 13′i) pulverulent, small, elliptical, surrounded by the longitudinally ruptured and incurved epidermis;

UREDOSPORES, obovate to subglobose, spinulose, mustard yellow (Ridgway, 19′b), 23 to 30 by 20 to 22.5 microns;

TELEUTOSORI, epiphyllous, crowded, black, sometimes surrounded by purple (Ridgway 69′ k) areolæ elliptical to linear, hemispherical in section, 0.2 to 2 microns long, occasionally confluent, surrounded by the longitudinally ruptured epidermis;

TELEUTOSPORES, ellipsoid to oblong, usually inserted laterally, apex rounded or occasionally elliptical, base rounded, rufous (Ridgway H′i), 30 to 39 by 19.7 to 23.4 microns, epispore smooth, 2.3 to 4.9 microns thick; pedicel persistent, hyaline, 78 to 180 by 3.8 to 5.5 microns.

Leaf-stripe. (*Helminthosporium sp.*)

The leaves of *Rottboelia exaltata* have sometimes been found to be affected by spots up to 5 cm. in length with buff coloured withered centres surrounded by a narrow brownish-purple border,

The spots bear on the under surface of the leaf a profusion of fuliginous, 2 to 4 times septate, cylindrical sporophores which measure up to 240 by 4 to 7 microns, and arise from the stomata in groups of one to four. They bear almost hyaline, thick walled, short ellipsoidal, spores which measure from 43 to 58 by 13 to 15 microns, and germinate at either pole.

SETARIA SULCATA RADD.

The conidial stage of an *Ustilaginoidea* occurs locally in the florets of this host-plant, and is illustrated on Plate XI by figure F. The sclerotia, which superficially resemble the effect of some of the smuts, are sub-globose, 3 by 2 mm., and composed internally of densely woven hyaline hyphæ. They are, at first, yellow and powdery owing to the production of large numbers of spores, but later become smooth and almost black externally. Those figured are in the earlier condition. The spores are spherical, bright yellow to olive green, somewhat tuberculate, 5 to 7 microns in diameter, and are borne by parallel fertile hyphæ on the surface of the sclerotium.

It is possible that the fungus may be referable to *U. ochracea* Henn. described as infecting *Panicum auritium* in the Phillippines and India.

The ascigerous stage has not been seen.

SPOROBOLUS PYRAMIDALIS BEAUV.

The inflorescences of this grass are commonly infected by *Helminthosporium ravenelii* Curt. The fungus, which is well known throughout the world where the host occurs, is illustrated by figures F & G on Plate VII. It produces a brown, velvety mass of branched sporophores on the floral parts of the host, and ultimately presents the appearance of a black, matted investment.

Another affection of the inflorescences of *Sporobolus pyramidalis* is caused by *Epichloë cinerea* B. & Br. and is shown in figure G of Plate VIII. In this case the inflorescence is compactly ensheathed by a stroma up to 8 c.m. in length by 2 mm. wide. The stroma is cream coloured but may appear to be brown owing to the number of purple-brown ostioles which protrude slightly from its surface.

The transverse section in the figure shows the flask-shaped, rather long necked, perithecia in which are produced the filiform, multiseptate ascospores.

UROCHLOA INSCULPTA STAPF.

An unidentified rust has been collected on this grass at Kumasi, and is shown on Plate IX, fig. C.

R. H. BUNTING,

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APPENDIX I.

SUMMARY OF LOCAL FUNGI DESCRIBED IN THIS BULLETIN.

Peronosporaceæ.

Sclerospora graminicola Schroet. on *Pennisetum typhoideum*.

Nectrieæ.

Gibberella moniliforme Wineland, on *Zea mays*.

Hypochytriaceæ.

Physoderma zeæ-maydis Shaw, on *Zea mays*.

Clavicipiteæ.

Epichloe cinerea Berk. and Broome, on *Sporobolus pyramidalis*.
Ustilaginoidea ?ochracea Henn., on *Setaria sulcata*.

Dothidiaceæ.

Phyllachora heterospora P. Henn., on *Panicum maximum*.

Pleosporaceæ.

Leptosphæria sacchari B. de H., on *Saccharum officinarum*,
Ophiobolus heterostrophus Drechs. (conidial stage only), on Zea *mays*.

Ustilaginaceæ.

Cintractia axicola (Berk.) Cornu var. *minor* Clin., on *Mariscus umbellatus*.
Sphacelotheca sorghi (Link) Clin., on Guinea-corn.
Tolyposporium penicillariæ Bref., on *Pennisetum typhoideum*.
Ustilago heterospora Henn., on *Panicum maximum*.
Ustilago zeæ (Beck.) Ung., on *Zea mays*.

Pucciniaceæ.

Puccinia maydis Béreng, on *Zea mays*.
Puccinia penniseti Zimm., on *Pennisetum typhoideum*.
Puccinia purpurea Cooke, on Guinea corn.
Puccinia rufipes Diet., on *Imperata arundinacea*.
Puccinia ? rottboeliæ Syd., on *Rottboelia exalta ta*.
Puccinia sp. on *Andropogon gabonense*.
Puccinia sp. on *Urochloa insculpta*.

Marasmieæ.

Marasmius sp. on *Zea mays*.

Sphærioidaceæ.

Botryodiplodia theobromæ Pat., on *Zea mays.*
Darluca filum, on *Puccinia.*
Diplodia mascrospora Earle, on *Zea mays.*
Phoma zeicola E. and Ev., on *Zea mays.*

Melanconiaceæ.

Colletotrichum andropogonis Zimm., on Guinea-corn.
Pestalozzia sp. on *Zea mays.*

Moniliaceæ.

Cephalosporium acremonium Corda, on *Zea mays.*
Piricularia oryzæ Br. and Cav., on *Oryza sativa.*

Dematiaceæ.

Acrothecum lunatum Wakk., on *Zea mays, Oryza sativa, Saccharum officinarum* & on Guinea-corn.
Cercospora sorghi E. & Ev., on Guinea-corn.
Clasterosporium maydicum Sacc. on *Zea mays.*
Helminthosporium oryzæ B. de H., on *Oryza sativa.*
Helminthosporium ravenelii Curt., on *Sporobolus pyramidalis.*
Helminthosporium turcicum Pass., on *Zea mays* and *Andropogon halepense.*
Helminthosporium sp. aff. *rostratum,* on *Zea mays.*
Helminthosporium sp. aff. *sativum, on Zea mays.*
Nigrospora oryzæ (B. & Br.) Petch, on *Oryza sativa.*
Nigrospora sphærica (Sacc) Mason, on *Zea mays.,*
Papularia sphærosperma (Pers.) van Höhn, on *Zea mays.*

Tuberculariaceæ.

Cerebella cenchroidis Subram. on *Pennisetum polystachyum.*
Epicoccum neglectum Desm., on *Zea mays.*
Fusarium heterosporum Nees forma *one* Wollenwr., on *Panicum maximum.*
Sphacelia sp., on *Andropogon Gayanus* Kunth. var. *bisquamulatus Häck.*
Sphacelia sp., on *Pennisetum typhoideum.*

Mycelia Sterilia.

Sclerotium sp., on *Melinis minutiflora.*

APPENDIX II.

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PLATE IV.

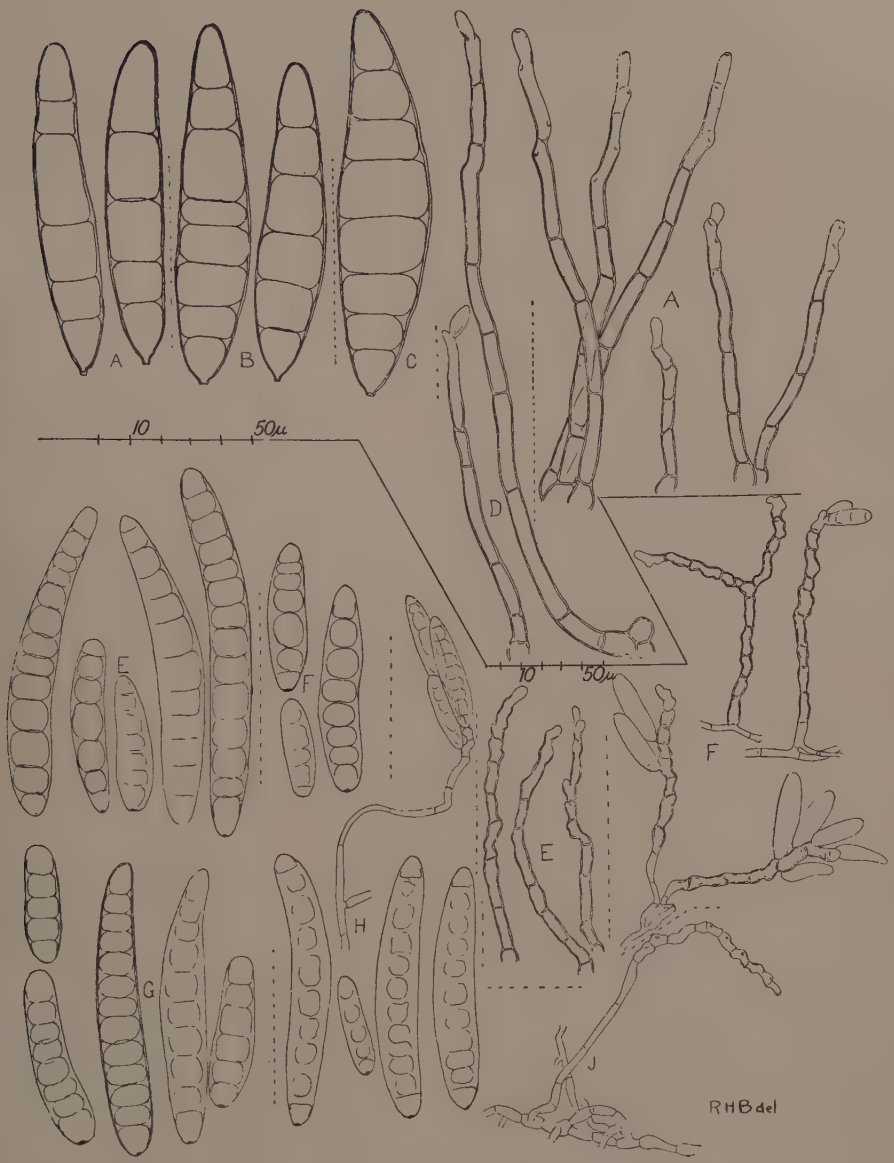
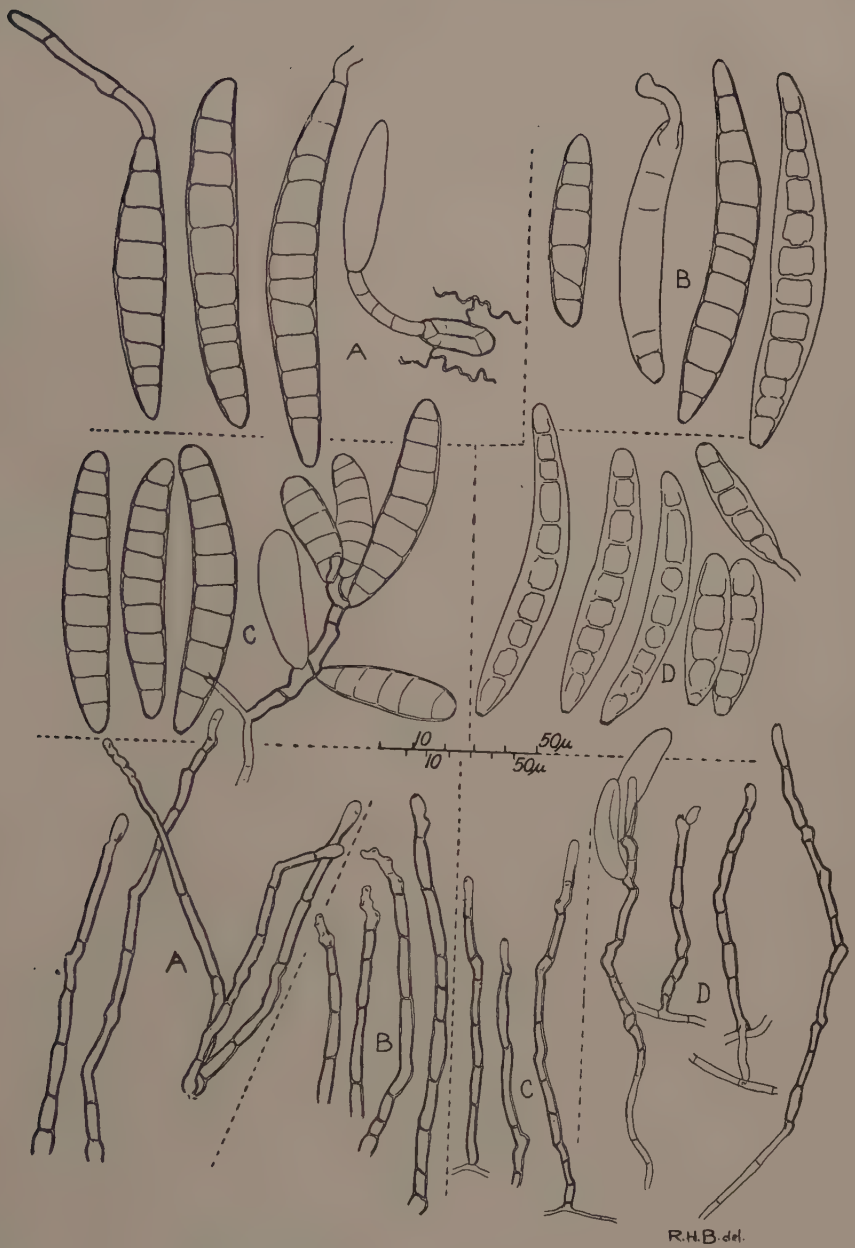


Fig. A.—*Helminthosporium turcicum* Pass. on Maize leaf, Aburi.
,, B. ,, ,, tap-water agar culture of A.
,, C. ,, ,, on Maize leaf, Krobo.
,, D. ,, ,, on leaf of *Andropogon halepense*.
,, E.—*Helminthosporium* aff. *sativum*, from mouldy patches on leaf-sheath of Maize.
,, F. ,, ,, ,, tap-water agar culture of E.
,, G. ,, ,, ,, occurring on blackened auricles of Maize.
,, H. ,, ,, ,, tap-water agar culture of G.
,, J. ,, ,, ,, tap-water agar culture from Maize leaf-spot II.

PLATE V.



Ophiobolus heterostrophus Drechsler, conidial stage.

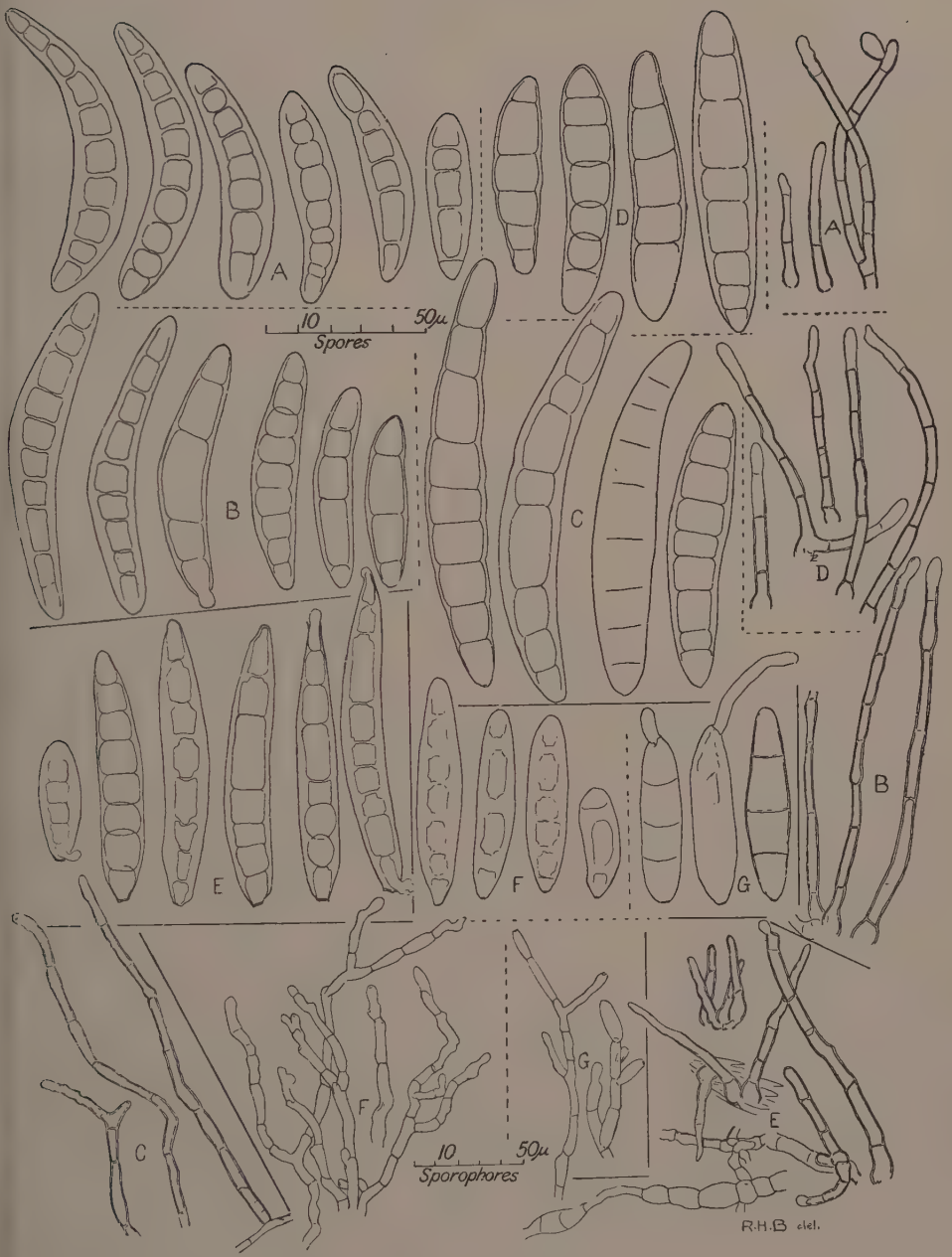
Fig. A.—On Maize leaf, Aburi.
,, B.—On staminate inflorescences of Maize, Aburi.
,, C.—Tap-water agar culture of A.
,, D.—Tap-water agar culture of B.

PLATE VI

Acrothecium lunatum Wakker sec. Mitra.

Figs. A and D.—On Maize leaf-spot II, Juaso.
Fig. B.—Tap-water agar culture of A.
,, C.—Cassva-mush agar culture of A.
,, E.—On Maize leaf-spot II, Aburi.
,, F.—On Rice glumes, associated with *Helminthosporium oryzae.*
,, G.—On mouldy patches on leaf-sheath of Maize, associated with *Helminthosporium* aff. *sativum.*
,, H.—*Helminthosporium curvulum* Sacc. from Baker's Fungi Malayana', No. 217.

PLATE VII.



Figs. A and D.—*Helminthosporium oryzae* B. de H., on Rice leaves, Ejura.
Fig. B.—*Helminthosporium* ,, ,, ,, Juaso.
,, C.—*Helminthosporium* ,, on Rice glumes, Adebrem.
,, E.—*Helminthosporium* sp. on leaves of *Pennisetum typhoideum.*
,, F.—*Helminthosporium ravenelii* Curt. on inflorescences of *Sporobolus pyramidalis.*
,, G.—*Helminthosporium ravenelii* Curt. tap-water agar culture of F.

PLATE VIII.

Fig. A. *Diplodia Macrospora* Earle, on Maize leaves and husks.
,, B. *Phoma zeicola* E. & E., on Maize leaves.
,, C. *Cercospora sorghi* E. & E., on Sorghum leaves.
,, D. *Piricularia oryzae* Br. & Cav. on Rice.
,, E. *Darluca filum* on *Imperata arundinacea*.
,, F. *Colletotrichum andropogonis* Zimm., on Sorghum leaves.
,, G. *Epichloe cinerea* B. & Br., on inflorescences of *Sporobolus pyramidalis*.
,, H. *Leptosphaeria sacchari* B. de H., on Sugar-cane leaves.
,, J. *Phyllachora heterospora* P. Henn., on leaves of *Panicum maximum*.
,, K. *Fusarium heterosporum* Nees. *forma one* Wollenw. on inflorescences of *Panicum maximum*.

PLATE IX.

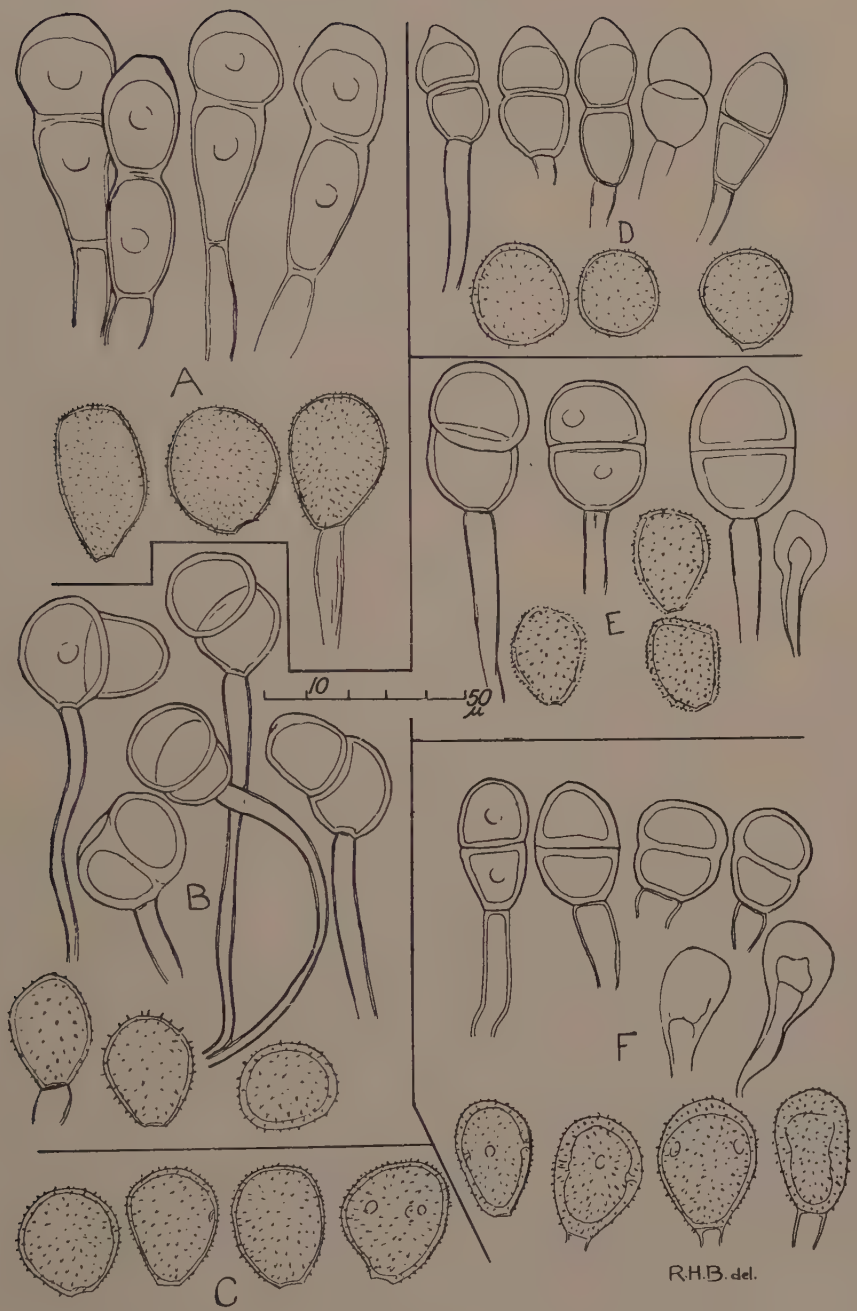


Fig. A. *Puccinia penniseti* Zimm., on *Pennisetum typhoideum.*
,, B. *Puccinia* sp., on *Rottboelia exaltata.*
,, C. *Puccinia* sp , on *Urochloa insculpia.*
,, D. *Puccinia maydis* Bér. on Maize.
,, E. *Puccinia* sp., on *Andropogon gabonense.*
,, F. *Puccinia rufipes,* on *Imperata arundinacea*

PLATE X.

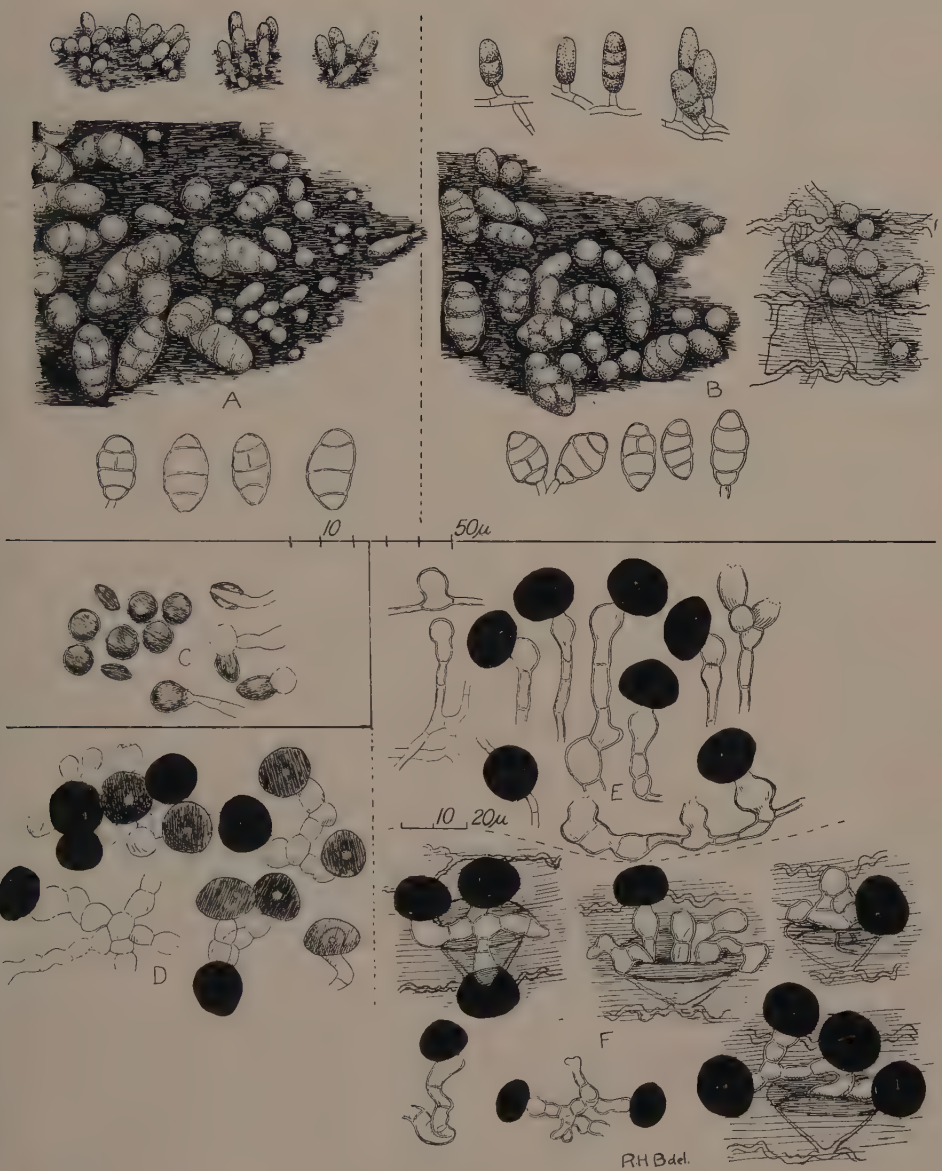


Fig. A. *Clasterosporium maydicum* Sacc., from Baker's Fungi Malayana, No. 217.
,, B. *Clasterosporium maydicum* Sacc., on Maize leaf, Aburi.
,, C. *Papularia sphaerosperma* (Pers.) v. Höhn, on Maize leaf.
,, D. *Nigrospora oryzae* (B. & Br.) Petch, on Rice leaves.
,, E. *Nigrospora sphaerica* (Sacc.) Mason, cassava-mush agar culture of F.
,, F. ,, ,, on Maize leaves.

PLATE XI.

Fig A. *Cerebella cenchroidis* Subram., on *Pennisetum Polstachyum*.
„ B. *Sphacelotheca sorghi* Clint. on Sorghum.
„ C. *Ustilago heterospora* Henn. on *Panicum maximum*.
„ D. *Tolyposporium penicillariae* Bref., on *Pennisetum typhoideum*.
„ E. *Sphacelia sp.*, on *Pennisetum typhoideum*.
„ F. *Ustilaginoidea* on *Setaria sulcata*.

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